REPORT OF THE IRRIGATION COMMISSION

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VOLUME II

Ministry of Irrigation and Power
NEW DELHI

Price : Rs. 25

PRINTED AT SREE SARASWATY PRESS LTD., CALCUTTA-9

PREFACE

In response to our Questionnaire most of the State Governments sent us data giving valuable information on the present status of development of irrigation in their States, their future aspirations and views on policy questions. We thought that the information received from the States should be made available to the Central Government and the other States in a standard form to give them a picture of the irrigation development, present and future. This Volume is the outcome of that effort.

2. The replies from the States were very exhaustive. We toured most of the States and some States more than once. This Volume contains our impression of tours also. We have drawn freely upon the material available in the various departments of the Central Government, the Planning Commission and research institutions. In view of the limitation of space, we have had to restrict our presentation only to essential matter.

3. Chapters in this Volume have been arranged in alphabetical order of the names of States. Meghalaya has been clubbed with Assam as separate statistics for the new State were not readily available. Information about some of the States such as Nagaland, Manipur and Tripura was limited and the Chapters dealing with these States have to be somewhat brief.

4. Our programme of tours was affected by the General Elections to the Lok Sabha in 1971 and to the State Assemblies in 1972. In some cases we could not plan our visits, as replies were received late or were incomplete. We have, however, done our best.

5. We have dealt with the financial aspects of irrigation development in detail in Chapter XI of Volume I of our Report. Once again we would like to stress the need for an early revision of water rates and recovery of betterment levy. The general tax-payer should not, in our opinion, be called upon to bear burden of irrigation development, except in the backward, arid and semi-arid areas. With the growing tempo of irrigation and rising investments from year to year, there has been an increasing loss from irrigation works. There is no reason, as we have pointed out in Volume I, why irrigated agriculture should not pay for a basic input like water. We trust, the State Governments will give immediate attention to the problem and take firm decisions.

6. Another important aspect of irrigation development, which should receive early attention, is the streamlining of the administrative machinery and procedure for ground water development. The States of Haryana and Punjab have set up Tubewell Corporations and have made appreciable progress during the last few years. Some other States have started organising their set up for ground water investigations but wherever preliminary studies promise the possibilitics of appreciable ground water resources, early steps should be taken to formulate a sound administrative system for the exploitation of ground water.

7. With the rapid expansion of rural electrification, there would be in-increased opportunities for providing lift irrigation facilities. Some of the States have already made remarkable progress in this direction. We would suggest that other States should profit from their experience and investigate lift irrigation schemes both from the surface and ground water. This is specially relevant to States which have plentiful ground water resources and to scarcity areas. The States should therefore carry out an assessment of their lift irrigation possibilities.

8. My colleagues and I once again take this opportunity to thank the various State Governments and the departments of the Central Government for the valuable assistance and cooperation given in our task. But for such help it would not have been possible for us to complete our task within the time at our disposal.

9. From 1st April, 1972 all the Members of the Commission except the Chairman, the Vice-Chairman and the Member-Secretary ceased to be in office. The staff of the Commission was also considerably reduced. Therefore my two colleagues, the Vice-Chairman and the Member-Secretary had to carry an extraordinary heavy burden in completing the remaining work of the Commission and I have pleasure in recording appreciation of their services. The Members of the Commission, Shri O. P. Gupta, Shri K. V. Ekambaram and Shri D. V. Reddy deserve special thanks for readily responding to my invitation to help in the deliberations of the Commission after ceasing to be its Members. The Director, the Deputy Directors and other officers of the Commission have worked ungrudingly in the preparation of this Volume and deserve our thanks for their untiring labours.

New Delhi
30th June, 1972

(AJIT PRASAD JAIN)

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CHAPTER I

ANDHRA PRADESH

1.1 Andhra was the first State in India to be formed on the basis of linguistic homogeneity in 1953. The Telugu speaking areas of the erstwhile Madras Province were included in the new State. Subsequently, when the reorganisation of States was undertaken in 1956, the Telangana area, which was also Telugu speaking, was detached from the former Princely State of Hyderabad and included in Andhra State to form the enlarged State of Andhra Pradesh.

Andhra Pradesh is the fifth largest State in India with an area of 276,754 sq. km. (106,855 sq. miles) and a population (1971) of 43.395 million people which makes it the fifth most populous State of the country.

With 81 per cent of the population living in villages, agriculture is the predominant occupation of the people and provides employment to nearly 70 per cent of the total working force. The population density is 157 persons per sq. km. against the all-India density of 182. The 1.2 million hectares of land irrigated by the magnificent canal systems of the Krishna and Godavari deltas make the area one of the largest and most intensive paddy growing areas in the country. These canal systems are monuments to the genius of Sir Arthur Cotton, who in 1830, as Captain Arthur Cotton of the Royal Engineers, rediscovered the importance and significance of the Grand Anicut across the Coleroon river which had been erected centuries earlier by the Chola Rulers of Thanjavur.

A fine network of small irrigation works, consisting mainly of tanks and small reservoirs dotted all over the State, adds greatly to its irrigation capacity.

Physiography

1.2 Topographically, there are four major divisions in the State—(*i*) the alluvial delta, (*ii*) the Deccan plateau south of the Krishna, (*iii*) the Deccan plateau north of the Krishna and (*iv*) the Eastern Ghats region.

The seven coastal districts of Srikakulam, Visakhapatnam, East Godavari, West Godavari, Krishna, Guntur and Nellore lie in the coastal belt which is comprised in the alluvial delta. The belt is 80 km wide and extends

for a distance of 965 km along the coast at an elevation of less than 152 m above sea level. The Eastern Ghats form the western fringe of this belt. The average precipitation of 1,015 mm. is from the south-west and the north-east monsoons.

The Deccan plateau south of the Krishna is an arid tract and lies at an altitude of 15 to 610 m above sea level and comprises the upland taluks of the coastal districts of Guntur and Nellore and the four Rayalaseema districts of Kurnool, Cuddapah, Anantapur and Chittoor. The scanty rainfall of 508 to 635 mm, which permits the growing of only one rain-fed crop, makes the region particularly subject to drought and famine. The topography is undulating with a high rate of erosion. The underlying geological formations are crystalline and hard sedimentary rocks.

The Deccan plateau north of the Krishna is an extensive plateau with an average elevation of 366 m above mean sea level, comprising, in addition to the upland taluks of the coastal districts of Krishna and West Godavari, the Telangana area of the former Princely State of Hyderabad. Telangana consists of the nine districts of Hyderabad, Nizamabad, Adilabad, Medak, Warangal, Khammam, Nalgonda, Karimnagar and Mehbubnagar. The average rainfall is about 762 mm. The predominant soil type is shallow loam. The plateau is traversed by the Krishna and Godavari rivers.

The Eastern Ghats region consists of thickly forested hills climbing to an altitude of 1,067 m above sea level, comprising the districts of Srikakulam, Visakhapatnam and East Godavari. It has a heavy rainfall ranging from 1,778 mm. to 2,540 mm.

Soils

1.3 The soils may be classified as—

(*i*) alluvial soils;
(*ii*) deep black soils;
(*iii*) medium black soils;
(*iv*) unclassified black soils;
(*v*) red soils; and
(*vi*) laterite soils.

Alluvial soils predominate in the lower reaches and the deltas of the major rivers, including the entire coastal belt which is at its widest in the districts of East Godavari, West Godavari, Krishna and Guntur. They support the rich rice and sugarcane crops, so typical of the deltas.

Almost all the deep black soils in the State, are concentrated in the Telangana region, largely along the northern border, from Adilabad district in the west to Khammam district in the east. This region contains the entire forested areas of Adilabad, Karimnagar, Warangal and Khammam districts.

Medium black soils are also confined to the Telangana districts and com-

prise a strip of land from north to south between two deep black soil zones, along the western border taluks in Nizamabad, Medak, Hyderabad, and Mahbubnagar districts.

Unclassified black soils are found in a continuous horse-shoe shaped belt running from the western limits of the Godavari, Krishna and Guntur districts, the southern part of Nalgonda district, and portions of Mahbubnagar, Kurnool, Cuddapah and Anantapur districts. While cotton is the chief crop, jowar, bajra, rice, sugarcane, tobacco, turmeric and chillies are also grown.

The whole of the Deccan plateau and a major portion of Rayalaseema are covered with red soils, and the three coastal districts of Srikakulam, Visakhapatnam and East Godavari have extensive areas of these soils. Bajra, ragi, pulses and groundnut are commonly grown, and where there is irrigation, cotton, tobacco and sugarcane are also grown.

To a very limited extent, laterite soils occur in some taluks of Medak, East Godavari, Nellore and Chittoor districts, and support pulses, fruit crops, coconut and rice.

Climate

1.4 Andhra Pradesh has a hot summer which extends from March to June, a rainy season from June to September-October, and a mild winter from November to March. However, Nellore and the Rayalaseema districts receive a considerable amount of their rainfall from the north-east monsoon. The peak of the summer is reached in May when temperatures go up to 50°C and even higher, in areas such as Bhadrachalam, Ramagundam and Vijayawada. The average summer temperature ranges between 37° and 40°C. Areas such as Anantapur and Chittoor districts, adjoining the Mysore plateau, enjoy a milder summer, as do the coastal areas. The lowest winter temperatures range between 16°C and 19°C, and temperatures are somewhat higher during the winter, along the coast.

Rainfall

1.5 Nearly two-thirds of the annual rainfall in the coastal districts and in the Telangana area, falls during the period of the south-west monsoon. The north-east monsoon is heaviest in the Nellore and Chittoor districts, though, during this period precipitation also occurs elsewhere in the State. The south-western districts of the State, which comprise the Rayalaseema area, lie in the rain-shadow of the Western Ghats, and precipitation is scanty. At the other extreme, the northern-most districts of the State, viz., Srikakulam and Visakhapatnam receive heavy rain as a result of the westward movement of low-pressure areas accompanied by cyclones. The range

of rainfall in the State is, therefore, extremely wide, ranging from 500 mm. per annum in Rayalaseema to over 1,400 mm. per annum in the north.

Land Use

1.6 Nearly half the geographical area of Andhra Pradesh is under cultivation. Of the remaining half, 22 per cent is under forests, 15 per cent is either barren or has been put to non-agricultural uses, and 4 per cent is under permanent pastures. This leaves only about 9 per cent of the area, consisting of land under miscellaneous trees and groves, culturable waste and old fallows, to provide room for the extension of cultivation in the future.

The need for resorting to the intensive utilisation of available land resources in the State is, therefore, obvious. However, at present, only 14 per cent of the net sown area is double cropped, though about 25 per cent of it receives irrigation. Table 1.1 indicates the land use pattern in the State in 1968-69.

Table 1.1

Land Use Pattern

(1968-69)

Classification	Area (Thousand hectares)	Percentage of Reporting area
1	2	3
Geographical area	27,676	
Reporting area	27,475	100.0
Forests	6,117	22.3
Area not available for cultivation		
(*a*) Area put to non-agricultural uses	2,115	7.7
(*b*) Barren and unculturable land	2,127	7.7
Total	4,242	15.4
Other uncultivated land excluding fallow land		
(*a*) Permanent pastures and other grazing land	1,157	4.2
(*b*) Land under miscellaneous tree crops and grooves not included in net area sown	308	1.1

Table 1.1—*contd.*

1	2	3
(*c*) Culturable waste land	1,332	4.9
Total	2,797	10.2
Fallow land		
(*a*) Fallow lands other than current fallows	918	3.4
(*b*) Current fallows	2,482	9.0
Total	3,400	12.4
Net area sown	10,919	39.7
Total cropped area	12,456	..
Area sown more than once	1,537	..
Net irrigated area	2,717	
Gross irrigated area	3,616	
Percentage of net irrigated area to net cultivated area		24.9
Percentage of gross irrigated area to gross cultivated area		29.0

Source: Directorate of Economics & Statistics, Ministry of Agriculture.

Cropping Pattern

1.7 Andhra Pradesh accounts for nearly 11 per cent of the rice, 13 per cent of the jowar, 14 per cent of the oilseeds, 10 per cent of the sugarcane and 50 per cent of the tobacco produced in the country. It holds a near monopoly in the production of castor and of virginia tobacco. It is also the largest producer of chillies in India.

About 79 per cent of the cultivated area of the State is under food crops. Because of the extent of fertile delta and coastal areas, paddy is the predominant crop and covers 23 per cent of the cropped area. Though the area under paddy in the State is 8 per cent (1968-69) of the total area in the country under this crop, it accounts for as much as 11 per cent of the total production. Andhra Pradesh is the third biggest rice producer in the country,

next only to West Bengal and Tamil Nadu. Other important food crops are jowar, bajra and ragi.

Among commercial crops, the most important are tobacco, castor, sugarcane, groundnut, cotton and chillies, and, as has been mentioned above, Andhra leads in the production of tobacco, castor and chillies. No less than four-fifths of the tobacco crop in the State comes from the four districts of Guntur, East Godavari, Krishna and Kurnool.

Table 1.2 illustrates the cropping pattern.

Table 1.2

Cropping Pattern

(1968-69)

Crop		Area (Thousand hectares)	Percentage of total cropped area
1		2	3
Rice		2,849	22.9
Jowar		2,765	22.2
Other cereals and millets		2,006	16.1
Total cereals and millets		7,620	61.2
Pulses		1,490	11.9
Total foodgrains		9,110	73.1
Sugarcane & others		158	1.3
Condiments and spices:			
(*a*) Chillies		169	1.3
(*b*) Others		123	1.0
	Total:	292	2.3
Fruits and vegetables:			
(*a*) Mangoes		127	1.0
(*b*) Others		129	1.1
	Total:	256	2.1
Other food crops		4	Neg.
Total food crops		9,820	78.8

Table 1.2—*contd.*

Oilseeds:			
(*a*) Groundnut		1,232	9.9
(*b*) Castor seed		265	2.1
(*c*) Others		330	2.7
	Total:	1,827	14.7
Cotton		301	2.4
Tobacco		230	1.8
Fodder crops		125	1.0
Other non-food crops		153	1.3
Total non-food crops:		2,636	21.2
Total cropped area:		12,456	100.0

Source: Directorate of Economics and Statistics, Ministry of Agriculture.

Water Resources

1.8 Andhra Pradesh has considerable water resources. Two of the major rivers of India, viz., the Krishna and the Godavari flow through it. There are, besides, 38 minor and medium river basins, 19 north of the Godavari and 19 south of the Krishna. Important among these are the Vamsadhara, Nagavali, Gundlakamma, Manneru and Penner river basins.

The rivers contribute about 185,052 m.cu.m. of water amounting to about 11 per cent of the total flow in all the Indian rivers, excluding the Brahmaputra. Out of this, about 61,674 m.cu.m. are being utilised in the head reaches of the rivers by the upper riparian States, viz., Maharashtra and Mysore, and about 32,083 m.cu.m. is the present utilisation in Andhra. Thus, about 91,294 m.cu.m. of water is left untapped. To sustain the large population engaged in agriculture and to step up food production, utilisation of this vast quantity of untapped water is imperative.

No study on the availability of shallow ground water aquifers ete., has been carried out on a systematic basis, though some random investigations have been made by the National Rural Water Supply Scheme. However, the utilisation of ground water at shallow depths through irrigation wells, is an age old practice in all the non-deltaic tracts. This practice is widely prevalent in the Telangana and Rayalaseema areas.

The ultimate irrigation potential of the State from different sources had been estimated as follows:—

	(Thousand hectares)
(1) *Surface sources*	
(*i*) Major and Medium Works	6480
(*ii*) Minor Works	2020

(2) *Ground Water Sources*		
Major & Medium Works		1820
	Total :	10320

(*Source:* Fourth Five Year Plan and Report of the Working Group on Minor Irrigation and Rural Electrification).

However, in the preliminary memorandum of the State Government to the Commission, it has been indicated that the ultimate irrigation potential from all sources would be only 8.66 million hectares.

Development of Irrigation

1.9 Till towards the close of the first half of the 19th century, irrigation in the areas which now form Andhra Pradesh, was through large numbers of tanks and wells. The Government of the day spent large sums on maintaining, repairing and improving tanks. The Public Works Development and the Revenue Department had taken over large numbers of tanks which commanded more than 80 hectares each.

The construction by Sir Arthur Cotton of the Godavari and Krishna anicuts in 1850's heralded a new era of large scale irrigation development, though the anicuts and canals built during this period, were all run-of-the-river schemes and did not involve any large-scale impounding of river waters behind storage dams.

The precarious tract of country known as Rayalaseema (the country of the Rayas) had been irrigated for centuries by 17 canals led through the rocky banks of the Tungabhadra to the fields. The waters of the river, supplemented by hundreds of wells, enabled the Rayas to maintain a precarious agriculture. However, by about the middle of the 16th century, these small works lapsed into disrepair and ruin, and, in consequence, the area became almost de-populated and its cities vanished. Almost three centuries later, in 1863, a new canal, viz., Kurnool-Cuddapah Canal, was drawn off from the Tungabhadra by a private company named 'The Madras Irrigation Company'. As originally designed, the Canal was designed to carry 85 cumecs, of which a part was to be used for irrigation and a part to maintain a navigable waterway between Kurnool and Cuddapah. The scheme for navigation was a failure. At the time when the First Irrigation Commission examined the Project, they found that "owing to original defects in the work and to the neglect of necessary annual repairs and the difficulty of getting money for expenditure on a work which had proved so unremunerative, a larger volume than 2,000 cusecs cannot be passed". In

practice, even less was passed, and the revenue returns were found to be insufficient even to meet the working expenses. Eventually, in 1882, the Government bought out the Company and took over the Canal, even though it was by then a patently unproductive work.

1.10 The First Irrigation Commission recommended the extension and improvement of the Canal. Till 1951, it irrigated 40,470 hectares. As a result of improvements effected to it since then it now irrigates 0.12 million hectares.

Another notable work carried out during this period was the construction, in 1887, of an anicut across the river Penner to irrigate areas in its delta.

The deltaic canals were pioneer works of their kind in the south, and like the great canals of northern India at that time, they were more or less inundation canals commanding level alluvial plains and drew their supplies from the rivers, by means of weirs or anicuts which held up the water and raised it to the level required for the canals. The Krishna anicut was near Vijayawada and that on the Godavari near Dowlaishwaram. The latter was the largest in the world at that time and consisted of a 4 km weir, embankments for a length of 2.4 km, and three sets of canal headworks.

The Krishna anicut had outlived its usefulness, by about the middle of the century and it was supplanted by the Prakasam barrage constructed just upstream of the anicut. A similar fate is overtaking the Godavari anicut which is being supplanted by a barrage upstream.

The First Irrigation Commission had recommended the construction of a storage reservoir on the Krishna, which, according to them, would permit the development of the Krishna Canal to its fullest capacity and would, at the same time, make it independent of supplies from the Tungabhadra. They expressed their approval of a proposal, then under investigation, to construct a storage work on the Krishna about 209 km above Vijayawada, with a dam 46 m high capable of impounding 0.9 to 1.2 m.cu.m. This would permit the construction of a high-level canal from the right bank of the river through the uplands of the Krishna district and on to the northern parts of the Nellore district.

1.11 Between 1918 and 1951, a number of irrigation works were taken up in the Deccan in areas which are now included in Andhra Pradesh, but which were then within the former State of Hyderabad. Table 1.3 gives some details of these schemes:—

Of all these earlier works, only the Nizamsagar Project would satisfy the definition of a major irrigation work. Constructed between 1930 and 1935, it consisted of a dam 48 m. high and 1,280 m long across the Manjra which is a tributary of the Godavari. A canal 155 km long irrigated 0.11 million hectares in the Nizamabad district.

Table 1.3

Irrigation Projects Taken Up in Andhra Pradesh during 1918-1951

Name of the Project	Source of Irrigation	Ayacut (Thousand hectares)	Cost (Rs. million)	Year of construction
1	2	3	4	5
Pocharam	River Manjra	5.26	2.75	1918
Wyra	River Yellandu	7.04	3.60	1923
Paleru	River Palleru	7.28	2.54	1923
Dindi	River Dindi	15.78	3.44	1940
Chandrasagar	Chandravagu	1.21	N.A.	N.A.
Maneru	Manery	6.98	9.80	1944
Koilsagar	Peddavagu	4.17	38.71	1949
Nizamsagar	Manjra	111.29	38.31	1935
Lakhnawaram	Salivagu	28.73	2.50	N.A.

N.A.=Not available.

At the beginning of the First Plan (1950-51), the net irrigated area in the Andhra State was 2.318 million hectares.

1.12 Since then, the State Government has pursued a vigorous policy of irrigation development, and, has undertaken works which rank among the largest of their kind. Of these, the prestigious Nagarjunasagar Project on the river Krishna takes pride of place. Other major projects are the improvement and remodelling of the K. C. Canal, the Tungabhadra Low-Level Canal, the Pochampad Project on the Godavari, the Kaddam Project on the river of that name, and the Tungabhadra High-Level Canal (Stage I and Stage II). Table 1.4 gives a list of works costing more than Rs. 10 million each undertaken since 1951.

Nagarjunasagar Project

The Krishna is one of India's major rivers with an annual run-off in its catchment of 46,872 m.cu.m. The area of the catchment is 251,359 sq. km. With a river of such dimensions carrying such a huge volume of water, it was only natural that it should have attracted the attention of irrigation engineers, particularly because of its potential as an insurance against drought and famine. However, it was only in 1851 that the first Krishna Delta Irrigation Scheme was sanctioned on the recommendations of a committee of experts. Construction was taken up in 1852 by Captain Orr

Table 1.4

Irrigation Projects Costing more than Rs 10 Million Each

Name of the Project	Estimated cost (Rs. million)	Ultimate benefits (Thousand hectares)
1	2	3
Nagarjunasagar Project	1,648.90	830.00
Pochampad Project	401.00	230.68
Kaddam Project	83.90	34.40
Musi Project	40.90	16.92
Tungabhadra High Level Canal (Stage I) (incl. Board)	190.00	48.21
Bhairavanithippa	14.53	6.86
Romperu Drainage Scheme	12.80	4.17
Upper Pennar Project	15.86	3.93
Rallapad Project Stage II	10.58	4.45
Tungabhadra Low Level Canal	134.50	60.25
Improvements to K.C. Canal	76.80	122.22
Rajolibanda Diversion Scheme	38.30	35.61
Swarna Project	11.56	2.83
Kanupur Canal	21.32	6.89
Vottigedda	14.25	6.75
Tungabhadra High Level Stage II	112.60	55.62
Guntur Channel	17.00	10.93
Varaha Reservoir	11.57	2.47
Thandava Reservoir	37.01	45.90
Krishna Barrage (Prakasam)	29.16	42.84

Source: India Irrigation and Power Project (Five Year Plans) CW & PC (April, 1970).

of the Madras Engineers and a weir, 1,021 m long, was completed with its canals and appurtenances in 1855.

In 1952, the talus of the weir gave way and endangered the anicut. As mentioned earlier, a new barrage was constructed in 1957, some distance upstream of the old anicut.

Meanwhile, several schemes had been proposed by the then Hyderabad and Madras Governments for utilising the Krishna waters, going back to 1903 when the Pulichintala scheme in Guntur district was proposed. In 1930, the Hyderabad Government proposed a scheme to be jointly implemented by Madras and Hyderabad for constructing a dam at Nandikonda. The scheme fell through because the Madras Government did not show any interest in it. In 1952, the Hyderabad Government reverted to its idea of a dam at Nandikonda. In the previous year, the Madras Government had

formulated the Krishna-Penner scheme which included the construction of a dam on the Krishna at Siddheswaram. The Khosla Committee set up by the Government of India in 1951 to examine and report on the most economic utilisation of the Krishna waters, recommended, inter-alia, the construction of a dam at Nandikonda with canals on both sides to irrigate areas in the State of Andhra and in the erstwhile State of Hyderabad. Based on these recommendations, the Nagarjunasagar Project was finally accepted as a two-phase project, to put a dam across the Krishna after its confluence with the Tungabhadra, at a point about 2.4 km below the village of Nandikonda where the width of the river gorge is 914.4 m. The dam is named after Nagarjunacharya, a savant and philosopher who lived in the vicinity in ancient times.

The dam is a straight gravity type rising 125 m above the average bed level with a length of 4,865 m of which 1,450 m is masonry and the rest earth. Live storage is expected to be 6,796.47 m.cu.m. (5.51 MAF), and irrigation water will be led to an area of 0.83 million hectares through two canals 203 km and 179 km long respectively.

While the work on the main dam has been completed, about 36 per cent of the work on the right bank canal and 20 per cent on the main left bank canal remains to be completed. Excavation for a length of 9,280 km and 1,985 km, on the right and left bank canals respectively, for field channels have been completed. Work on the branches and distributaries is progressing well.

Pochampad Project

The project envisages the construction of a masonry and earth dam, 43 m high across the Godavari near Pochampad in the Nizamabad district. The live storage capacity of 2,269.60 m.cu.m. (1.84 MAF) is expected to irrigate 0.23 million hectares in Nizamabad and Karimnagar districts through a 121 km long canal.

Kaddam Project

In this project a composite dam is planned across the Kaddam, a tributary of the Godavari. The dam which is 41 m high and 2102 m long, will irrigate an area of 34,400 hectares in the district of Adilabad through a canal system in which the main canal is 77 km long. It is planned to store 215.24 m.cu.m. (0.17 MAF) of water.

Rajolibanda Diversion Scheme

The Governments of Mysore and Andhra Pradesh have jointly erected a

weir across the Tungabhadra, 138 km downstream of the Tungabhadra dam to irrigate 35,610 hectares in the Mahbubnagar district of Andhra Pradesh.

Musi Project

The Musi Project comprises a 21 m high dam across the river Musi in the Krishna Basin to irrigate 16,920 hectares in the Nalgonda district.

The Salient features of irrigation works where the command is more than 4,045 hectares in each case are given in Appendix 1.1.

Ground Water

1.13 As in other parts of India, irrigation wells are ubiquitous in Andhra Pradesh and at the end of the First Plan period they numbered 322,000. By the end of March, 1969, the number had risen to 4,84,000. During the same period, the number of tubewells increased from 16,200 to 28,000.

Areas irrigated by wells (including tubewells) displayed a similar rise, from 0.29 million hectares in 1950-51 to 0.47 million hectares in 1968-69. However, only the shallower aquifers were exploited by these wells, and until very recently no deep tubewells had been drilled.

Systematic ground water surveys were carried out between 1959-1962 over an area of 5,340 sq. km by the Ground Water Division of the Geological Survey of India. The survey covered the sedimentary areas of the Krishna, West Godavari, East Godavari, and Nellore districts of the State and based on this survey, exploratory drilling began in 1958 at fifteen sites in the first three of these districts. Of the sites, 11 were found suitable for the installation of permanent tubewells, each producing a minimum of 91 thousand litres per hour.

Table 1.5 shows the areas irrigated from surface and ground water resources (1968-69).

Ayacut Development

1.14 The Andhra Pradesh Government is of the opinion that in ideal conditions, it takes about two years for the farmer to take to irrigated agriculture. If water is made available in time, and in reasonable quantities throughout the crop season, 80 per cent of the ayacut can be developed in the first season. This opinion is very largely based on actual experience in the Nagarjunasagar ayacut, where the development had been planned to deal with the various factors which usually impede full ayacut development. The steps taken by the Government in developing the Nagarjunasagar ayacut are briefly indicated below.

Table 1.5

Source-wise Irrigation—1968-69

Source	Area irrigated (thousand hectares)	Percentage to total
Government Canals	1,381	50.8
Private Canals	14	0.5
Tanks	773	28.5
Tubewells	56	2.1
Other wells	411	15.1
Other sources	82	3.0
Total:	2,717	100.0

Agriculture

The problem was to convert land on which dry crops had hitherto been grown, into land on which irrigated crops could be grown. This involved land-shaping and levelling according to the degree of slope. Experience showed that when the slope was less than 2 per cent, it could be made suitable for irrigation by manual labour alone; above this slope, the use of machinery became necessary. The State Government estimates that in the Nagarjunasagar ayacut one-fifth of the total localised area on the left bank canal and one-tenth of the total localised area on the right bank canal would require reclamation by machines. At present 119 such machines are in operation, and the State Government proposes to purchase additional units to the value of Rs. 17 million during the Fourth Plan.

Soil Survey

Since irrigation may necessitate a change in the cropping pattern, the State Government at the time of executing the project, carried out soil surveys in the ayacut and prepared semi-detailed soil maps on which the localisation of crops could be based. It is proposed to prepare detailed soil maps for each village, to serve as a basis for tendering advice to the farmers, as to the kind of crops they should grow and as to the manuring they should do.

Soil analysis is being done at three laboratories established for the purpose.

Seed Farms

A change in the cropping pattern can only be brought about if seed for the new crops is made available. To meet the demand for improved new seeds, three State farms have been set up to produce five thousand quintals of paddy and five thousand quintals of jowar and bajra seeds. A sum of Rs. 5.0 million has been provided for the development of these farms during the Fourth Plan.

Project Development and Demonstration Farms

Research to establish the most suitable cropping pattern for the ayacut is being done at the Research Stations at Gorkapadu and at Amaravati. The first station is studying problems relating to the red soils on the left bank of the river and the other, problems relating to the black soils of the right bank. Varietal trials are being done at both research stations on paddy, cotton, groundnut, maize, bajra, etc.

The State Government proposes to initiate other measures such as intensive agricultural development, field demonstrations, plant protection programmes, cattle breeding farms and key-village centres, etc., to lend support to the programme of ayacut development and to strengthen the agricultural and animal-husbandry base.

To provide finance to the farmers for reclaiming and developing land, the Andhra Pradesh Cooperative Central Land Mortgage Bank advances long-term loans. A sum of Rs. 26.50 million for developing 36,000 hectares of land in the ayacut of various projects in the State, including Nagarjunasagar, were advanced by the Bank between 1965 and 1968. The Agricultural Re-finance Corporation has also extended assistance to the development of Nagarjunasagar command through a phased programme drawn up by the Central Land Mortgage Bank, Hyderabad.

Drought-affected Areas

1.15 When the First Irrigation Commission was studying the development of irrigation, it found that excluding seven districts of the then Presidency of Madras, namely, South Kanara, Malabar, Godavari, Krishna, Thanjavur, Visakhapatnam and Tirunelveli, the rest of the Presidency, except where irrigation had been provided, was liable to recurrent drought and famine. Three of the seven secure districts, namely, Godavari, Krishna and Visakhapatnam are now included in the State of Andhra Pradesh.

The most insecure were what were known as the Deccan districts, comprising Kurnool, Cuddapah, Anantpur and Bellary which had been frequently afflicted by famines. Except for Bellary which is now a part of

Mysore, the other three districts are now part of Andhra Pradesh and their sole protection, such as it was, was given by the Kurnool-Cuddapah Canal. Irrigation in Kurnool at that time was 7 per cent of the cultivated area; in Anantpur 13 per cent; Cuddapah was slightly better off with 20 per cent, largely because of irrigation from a large number of tanks and wells. However, as the First Irrigation Commission pointed out, in a year of severe famine, like that of 1876, the area protected by irrigation in this district fell by almost 50 per cent.

Generally, the drought affected areas lie in the Rayalaseema and Telangana regions, where rainfall is scanty, unevenly distributed and liable to serious deficiency. Between the years 1900-1959, famine or near famine conditions prevailed as many as 11 times in Rayalaseema, 6 times in Telangana and 14 times in some other areas of Andhra. The State considers 71 taluks in 10 districts to be drought affected.

1.16 The Commission has identified 60 taluks in 7 districts of the State as susceptible to drought. They include the whole of the districts of Anantapur (11 taluks), Kurnool (13 taluks) and Nalgonda (7 taluks), 10 taluks of Mehbubnagar, 8 taluks of Cuddapah, 7 from Chittoor and 4 from Hyderabad. These are given in Table 1.6.

Table 1.6

Taluks Identified as Drought-affected in Andhra Pradesh

(i) *Anantapur District*

(1) Anantapur	taluk
(2) Tadpatri	,,
(3) Dharmavaram	,,
(4) Kalyandurg	,,
(5) Rayadurg	,,
(6) Penukonda	,,
(7) Madakasira	,,
(8) Hindupur	,,
(9) Kadiri	,,
(10) Gooty	,,
(11) Uravakonda	,,

(ii) *Chittoor District*

(12) Chittoor	taluk
(13) Chandragiri	,,
(14) Madanapalli	,,
(15) Vayalpad	,,
(16) Pungunur	,,
(17) Palamaner	,,
(18) Kuppam	,,

(iii) *Cuddapah District*

(19) Cuddapah	taluk
(20) Kamalapuram	,,
(21) Rayachoti	,,
(22) Rajampet	,,
(23) Badwel	,,
(24) Jammalamadugu	,,
(25) Proddatur	,,
(26) Pulivendla	,,

(iv) *Kurnool District*

(27) Markapur	taluk
(28) Kurnool	,,
(29) Dhone	,,
(30) Nandikotkur	,,
(31) Adoni	,,
(32) Aluru	,,
(33) Pattikonda	,,
(34) Koilkuntla	,,
(35) Banganpalli	,,

Table 1.6—*contd.*

(36) Allagadda taluk
(37) Giddalur ,,
(38) Atmakur ,,
(39) Nandyal ,,

(v) *Hyderabad District*

(40) Hyderabad (West)
(41) Ibrahimpatnam
(42) Hyderabad (East)
(43) Chevella

(vi) *Mahbubnagar District*

(44) Kalwakurthi taluk
(45) Nagarkurnool ,,
(46) Wanaparthi ,,
(47) Alampur taluk
(48) Makthal ,,
(49) Shadnagar ,,
(50) Achampet ,,
(51) Kolapur ,,
(52) Gadwal ,,
(53) Atmakur ,,

(vii) *Nalgonda Disttrict*

(54) Suryapet taluk
(55) Bhongir ,,
(56) Huzurnagar ,,
(57) Devarakonda ,,
(58) Miryalguda ,,
(59) Ramannapet ,,
(60) Nalgonda ,,

These 60 taluks account for over one-third of the geographical area of the State and one-fourth of its population.

Undoubtedly, irrigation is the prime need in these areas to protect their precarious agriculture. Considerable effort has been made to harness the flows of rivers traversing these tracts, particularly since Independence. Most of the major and medium irrigation works taken up in the State benefit portions of the drought areas. Table 1.7 gives a list of projects under construction in the drought areas of Andhra Pradesh.

Table 1.7

Irrigation Works under Construction in Drought Areas of Andhra Pradesh

Project	Drought districts which benefit	Continuing from	Irrigation benefit (thousand hectares)
1	2	3	4
Nagarjunasagar	Nalgonda & Kurnool	I Plan	829.64
Musi	Nalgonda	,,	16.92
Tungabhadra H.L. Canal, Stage I	Anantapur & Cuddapah	II Plan	48.21
Tungabhadra H.L. Canal, Stage II	Kurnool, Bellary, Cuddapah & Anantapur	Annual Plan	55.62
Rajolibanda Diversion	Mahbubnagar	I Plan	35.61
Okachetti Vagu	Mahbubnagar	Annual Plan	2.71

Table 1.7—*contd.*

1	2	3	4
Gajuladinne	Kurnool	,,	5.06
Kotipalli Vagu	Hyderabad	III Plan	4.04
Kanupur Canal	Nellore	III Plan	6.89
Gandipalem	Nellore	Annual Plan	4.05
Bahuda Reservoir	Chittoor	Annual Plan	1.17

It would be observed that three of the projects listed in the table, which were taken up in the 1st or the 2nd Plan are still incomplete. We recommend that they be given priority in the allocation of funds to ensure their early completion.

When the above schemes come into full operation, the proportion of the cultivated area benefiting from irrigation in the drought districts would increase from 18 to 24 per cent. We need hardly emphasise that these works should be completed expeditiously so that their irrigation potential can be fully realised.

1.17 For further protection of the drought areas, the State Government has suggested a few more irrigation works of which the more important are given in Table 1.8.

Table 1.8

Irrigation Works Proposed in Drought Areas

Project	Districts benefited	Irrigation potential (Thousand hectares)
1	2	3
Pulivendla	Cuddapah	22.26
Upper Krishna (extension to A.P.)	Mahbubnagar	78.84
Bhima Project	,,	161.87
Tungabhadra L.B. Low-level Canal (extension to A.P.)	,,	48.56
Rajolibanda R.B. Canal	Kurnool	16.19
Varadarja Swamy	,,	2.19
Sangameshwaram Canal, Stage I	Kurnool & Cuddapah	145.08

Table 1.8—*contd.*

Sangameshwaram Canal, Stage II	Nellore	291.37
Nagarjunasagar, Stages II and III	Nalgonda & Kurnool	1,310.76
Togurpet (Cheyyeru)	Cuddapah	N.A.
Papagni Reservoir	Cuddapah & Anantapur	N.A.
Peddavagu	Chittoor	N.A.

N.A. = Not available.

Projects like Nagarjunasagar Stages II and III, the Sangameshwaram Canal and the Bhima project have considerable irrigation potential and would greatly benefit districts like Kurnool, Nalgonda, Cuddapah and Mehbubnagar. However, most of these schemes have not been fully investigated. In view of the large irrigation benefits which they can provide to drought areas, it is desirable that feasibility studies on these projects should be undertaken urgently and those found fit be given priority in implementation.

Besides the above schemes the following inter-basin diversion schemes may also be investigated:—

(*i*) diversion of waters from the Krishna by taking up Nagarjunasagar Stage II and the Somasila Projects; and

(*ii*) diversion of the flood flows of the Krishna to the Rayalaseema region from the Srisailam reservoir for the purpose of recharging ground water aquifers.

To augment the supply of irrigation water from ground water sources, new wells are being sunk, oil engines and pump sets are being installed to lift water from wells, and tanks are being restored and renovated. Ground water resources are being studied to discover new aquifers and to determine the safe yield from aquifers now being tapped.

To lessen the impact of drought, studies are also being conducted to evolve drought resistant varieties of crops. The raising of orchards in these areas is being encouraged. There is also a big programme of soil conservation to conserve available water and to recharge the ground water by soil conservation methods, like contour bunding, gully plugging and the construction of head-water tanks. The progressive denudation of the forests is sought to be halted by a programme of afforestation.

Future Development of Irrigation

1.18 The State Government has investigated a number of irrigation, hydro-electric and multi-purpose projects on the Godavari, the Krishna, the Penner and a number of smaller rivers which flow into the Bay of Bengal,

like Vamsadhara, Nagavali and Sarada, etc. A list of the more important projects is given below:

Table 1.9

Future Major Projects

Project	River	Area proposed to be irrigated (Thousand hectares)
1	2	3
Inchampalli	Godavari	121.41
Polavaram Barrage	Godavari	309.99
Pranhita	Pranhita	60.70
Pulichintala	Krishna	
Vamsadhara	Vamsadhara	
Yeluru Reservoir	Yeluru	
Nagavali	Nagavali	
Sangameshwaram Canal, Stages I & II	Krishna	436.26
Pulivendla	Penner	
Somasila	Penner	
Upper Krishna	Krishna	72.84
Bhima	Bhima	161.88
Nagarjunasagar, Stages II & III	Krishna	
Ippur Reservoir	Godavari	

In addition to the major projects listed above, there is considerable scope for a number of medium irrigation schemes in all the river basins and many such schemes are now being investigated.

There is also need for the restoration and renovation of tanks, for improving existing irrigation works, for the lining of canals and for the extension of irrigation through better management and changes in the cropping pattern, and through the expansion of well irrigation. According to available estimates, the ultimate potential from ground water sources in the State is about 1.8 million hectares. Actual irrigation from wells and tubewells amounted to only about 0.66 million hectares, which is hardly one-fourth of the potential. There is thus considerable scope for development of irrigation from ground water sources.

Taking into account all sources of irrigation in the State, the ultimate potential comes to 10.32 million hectares.

Floods, Water-logging and Drainage

1.19 The major rivers flowing through Andhra Pradesh, namely, the

Krishna, the Godavari and the Penner flow, like all Deccan rivers, in deep and well-defined courses till they debouch from the Eastern Ghats into the deltaic plains. It is at this stage that there are flood problems. However, these problems have been solved to a large extent by the construction of storage and flood control reservoirs in the upstream reaches of the Krishna and its tributaries, and by flood embankments in the deltas.

Apart from the Kolleru lake, the flooding is being caused by a number of coastal rivers which rise in the Eastern Ghats and which overflow their banks during periods of heavy precipitation in their catchment areas. Apart from expedients such as diverting part of the Budameru flood waters into the Krishna above Vijayawada, which have proved to be of only limited utility, the State Government proposes to construct flood-moderating reservoirs on some of the more troublesome rivers, to avoid almost yearly inundations.

However, the most complex flood problem arises from the periodic and widespread submergence of lands around lake Kolleru, which lies in a natural depression between the Krishna and the Godavari. The severity of the problem can be gauged from the fact that for every 0.3 metre of rise in the water level of the lake beyond R.L. +5.0, about 10,000 hectares of irrigated land are submerged, sometimes because of inadequate drainage. The Kolleru Lake has a catchment of nearly 4,760 sq. km and four large rivers, the Budameru (1,889 sq. km), the Ramileru (308 sq. km), the Thammileru (1,355 sq. km), and the Gunderu (539 sq. km), apart from other small streams, drain into the lake. As against the maximum discharge of 3,141 cumecs, which these rivers bring into the lake, the capacity of the Upputeru drain, which is the sole outlet from the lake, is only 319 cumecs (at RL+10) or roughly one-tenth. The result of this imbalance can well be imagined.

A special committee of experts was set up by the Union Ministry of Irrigation & Power in 1964 to study the problem of flooding in the Kolleru lake and to suggest remedies for the control of floods caused by the coastal rivers. It recommended the construction of flood detention reservoirs across the Budameru, the Thammileru and the Yarrakalva; the enhancement of the flood carrying capacity of the Upputeru from 118 cumecs to 425 cumecs in the first instance, and then to 566 cumecs at RL+7, and the widening and deepening of suitable sections of the drains in the delta areas to enlarge their capacity and increase their efficiency. A special drainage circle at Eluru, with five divisions, is carrying out these recommendations.

During our visit, our attention was particularly drawn to the necessity for an early solution of the problem posed by the flooding of the Kolleru, and we would recommend that adequate funds be provided as early as possible so that the proposals of the expert committee can be quickly implemented.

Water Rates

1.20 In new irrigation projects constructed after 15th August, 1947, a water cess is levied at the following rates:—

	Rate per acre
(*a*) For the first or single wet crop on dry land	Rs. 15.00
(*b*) For the irrigated dry crop on dry lands	Rs. 10.00
(*c*) For dofasal crop other than sugarcane or for two wet crops	Rs. 22.50

In projects completed prior to Independence, different scale of rates are charged as indicated below:—

Rates under standard scale of water cess

(a) Deltaic area	Rate per acre	
	First class irrigation Rs.	Second class irrigation Rs.
(i) First crop, if wet	12.50	10.00
(ii) First crop, if dry	6.25	5.00
(iii) Second crop, if wet and following a first wet crop	12.50	10.00
(iv) Second crop, if wet and following a first dry crop	12.50	10.00
(v) Second crop, if dry	6.25	5.00
(vi) Third crop, if wet	5.00	4.00
(vii) Third crop, if dry	2.50	2.00

Note:—The charge leviable for two wet crops (first and second crops) will be levied on a dofasal crop other than sugarcane.

(b) Non-deltaic areas	First class source	Second class source
(i) First wet crop	8.00	6.00
(ii) First dry crop (systematically irrigated)	6.00	4.50
(iii) First dry crop (occasionally irrigated)	4.00	3.00
(iv) Second wet crop following wet crop	4.00	3.00
(v) Second dry crop (systematically irrigated) following wet crop	3.00	2.25
(vi) Second dry crop (occasionally irrigated) following wet crop	2.00	1.50
(vii) Second wet crop following dry crop (systematically irrigated)	5.00	3.75
(viii) Second dry crop (systematically irrigated) following dry crop (systematically irrigated)	4.00	3.00
(ix) Second dry crop (occasionally irrigated) following dry crop (systematically irrigated)	3.00	2.25

(x) Second wet crop following dry crop (occasionally irrigated)	6.00	4.50
(xi) Second dry crop (systematically irrigated) following dry crop (occasionally irrigated)	5.00	3.75
(xii) Secondry crop (systematically irrigated) following dry crop (occasionally irrigated)	4.00	3.00
(xiii) Dofasal crop (other than sugarcane)	12.00	9.00

From time to time, the Collectors have to modify the list of crops to be regarded as systematically irrigated and as occasionally irrigated.

Rates under Differential Water Rate System

1.21 Under this system water cess on dry lands is charged at a rate equivalent to the difference between the wet and dry assessment. The rates for the various crops are:—

Description of crop	*Rate per acre*
(i) For a single wet crop	The difference between the wet and dry assessment.
(ii) For second or third wet crop	One half of the charge shown against item (*i*) above, plus half the dry assessment.
(iii) For a first, second or third dry crop	One third of the charge shown against item (*i*) above.
(iv) For dofasal crop other than sugarcane	The sum of the charges specified against items (*i*) and (*ii*) above.

Betterment Levy

1.22 According to the Betterment Levy Act of Andhra Pradesh, the levy should not exceed one half of the increase in the value of land, on account of the construction, expansion or alteration of an irrigation work. The levy is recoverable in not more than 20 annual instalments, beginning after the expiry of three years from the date of the completion of the work. Between the years 1961-62 and 1968-69, the State Government has recovered a sum of Rs. 4.42 million as betterment levy.

Tours, Observations and Impressions

1.23 We toured the State from the 12th to the 22nd May, 1970, travelling by road and visiting a number of irrigation works. We held discussions with a large number of persons including State and District officials, Mem-

bers of Parliament and of the State Legislature and farmers. On the 21st May, we held discussions at Hyderabad with the Chief Minister and his colleagues.

The Chief Engineers, the Director of Agriculture and other officers accompanied us throughout the tour, which enabled us to discuss with them a great many problems in detail. We also discussed with the District Collectors and District officials, the problems of the areas which we visited. Detailed memoranda relating to individual projects and to problems of irrigation were presented to us by Members of the State Legislature, farmers and others, and in most cases the viewpoints were also explained to us in person. Some of the more important matters arising out of our visit are discussed below:—

Irrigation Problems in the Godavari and Krishna Delta Canal Systems

1.24 It was represented to us that the present system for the distribution of water in the delta areas, under which the transplantation of paddy is spread over a period of seven weeks, commencing in the first week of June, presents serious problems for certain categories of farmers. The supply of irrigation water for the transplantation of paddy is continued up to the third, and even the fourth week of July. Some holdings in the tail-end areas of the canals get water only towards the end of July, because of the heavy demand and unauthorised cuts and breaches in the canals in the upper reaches. This inordinate delay in getting water affects the farmers in the tail-end areas in two ways. Firstly, late transplantation, particularly of traditional varieties, reduces yields, and, secondly, because of late transplantation, the heavy rain in August finds the crop at a stage of growth when it is unable to stand submersion for long periods without serious damage. Timely transplantation would obviate this danger.

The general opinion of the farmers was that the period of transplantation should be reduced from seven weeks to three weeks. Since the canals and outlets have not been designed to irrigate the whole delta area in a period shorter than seven weeks, they will probably have to be remodelled if the period is to be reduced, as suggested, to three weeks. However, we appreciate that this remodelling of existing canals is fraught with a great many difficulties, particularly in the head reaches where the canals pass through the town of Vijayawada.

A possible, and, perhaps, more feasible, alternative would be to advance the opening of the canal from the first week of June to the middle of May. This would be possible if the dams higher up the river could conserve some water from the preceding season as a carry-over, to assist transplantation irrigation in the delta area. We could suggest that the feasibility of this alternative should be examined, since it may be possible for the Nagarjuna-

sagar Reservoir to give some early supplies of water for transplantation in the Krishna delta. Perhaps, later on, this supply could be given by the Pulichintala Project.

As for the Godavari delta, we feel there should be some scope for giving early supplies from the Machkund Project to meet the transplantation needs of the delta, and this supply would be augmented on the completion of the Balimela Dam. There is also the possibility of regulating releases from the hydro-electric projects which have been proposed for the Godavari valley, to support the system of giving early irrigation water for transplantation in the delta.

Drainage

1.25 Drainage appears to be a pressing problem in the deltas. We were told that most of the drains have been choked by the growth of weeds, like the water hyacinth, or obliterated by the encroachment of cultivation, or are being used for the irrigation of lands adjoining them. Irrigation is being steadily increased to meet the requirements of a second paddy crop in the delta, and the necessity for efficient drainage in the delta area is imperative if large-scale water-logging and consequent damage is not to take place.

We were happy to note that the State Government has already sanctioned a drainage scheme for the delta areas and that machines are to be used on a large scale to ensure speedy implementation. However, we were given to understand that adequate funds were not available to complete the work. In view of the critical importance of this scheme to the drainage of the deltas, we would stress the urgency of providing adequate funds to ensure its early implementation.

Nagarjunasagar Project

1.26 The Commission was glad to note that the special efforts made in the command of this project had helped to accelerate the pace of utilisation of the irrigation potential from the first year after water was let out. These efforts comprised the following:—

(*i*) organisation of special teams of local officers to solve the problem at the field level and to ensure timely supply of inputs;

(*ii*) digging of field channels by the Irrigation Deptt., the cost to be recovered later from beneficiaries; and

(*iii*) grant of concessional water rates.

1.27 Though the State Government had done a great deal to provide a network of roads in the ayacut, a number of persons who met us during our visit brought to our notice that a great deal remains to be done. It

appears to us that an accelerated programme of road development is called for to improve communications in the ayacut and to provide marketing facilities. Where marketing centres are inadequate, new centres with sufficient storage facilities, may be established under the 'Area Development Programme' which we have described in Volume I, Chapter VII of our Report.

1.28 We also noticed that facilities for the inspection of distributaries had not been provided, and we are afraid that this will reduce the efficiency of inspection and the standard of maintenance of canals. In our opinion, the Section Officer should be able to reach any point on the canal system at short notice, which is possible only if proper roads are provided on minors and distributaries. This matter requires the urgent attention of the State Government.

1.29 In view of the shortage of irrigation water and the necessity to make the most of the water impounded by the Nagarjunasagar dam, we are of the view that the question of lining the canals and distributaries which serve the ayacut should be examined to see what additional dry crops can be irrigated by the water saved.

1.30 We have already mentioned the general problem of drainage in the delta areas, but we would like to emphasise that the problem of drainage in the ayacut of the Nagarjunasagar dam also requires urgent attention. In the absence of a comprehensive drainage scheme for the ayacut, the dimensions of the problem, which are even now considerable, can only increase to the detriment of agriculture in the area, and we would urge the State Government to take steps to formulate such a scheme as a matter of the highest priority and to ensure its speedy implementation.

1.31 The Commission came across a very promising cooperative venture during its visit to the Nagarjunasagar Left Bank Canal in Nalgonda district. 700 owner cultivators belonging to seven neighbouring villages had pooled 2,430 hectares of their land to form the Mahatma Gandhi Lift-Irrigation Society, Ltd., registered in February, 1969. These lands were being developed as one unit to be irrigated by community-owned lift-pumps. After levelling the land, and laying field channels, drainage channels and roads, 90 per cent of the pooled land would be redistributed among the members for cultivation and the remaining 10 per cent would be retained for joint operation.

When the Commission visited the Society's farm in the summer of 1970, part of the lift irrigation works, including off-take sluices, electricity-lines, transformers, and electric motors had been installed and pumps were work-

ing. Operations like land-levelling, laying of roads, drains, channels, etc., were in progress. More than two-thirds of the land had been bunded and levelled. Field channels had been excavated, 65 per cent by bulldozers and 35 per cent by manual labour. Of the 160 km of roads required for the project, more than 6 km of main roads and 40 km of branch roads had been laid. Over a dozen tractors were in operation and the cooperative had placed orders for another thirty. About 486 hectares had been brought under crops in rabi 1969-70 and 810 hectares were under preparation for rabi 1970-71. A qualified agronomist-member of the Society was in overall charge of matters like laying out distributaries and field channels, land levelling, crop planning and crop rotations. Government agencies were also helping the Society with technical advice and guidance.

The scheme was meant to be self-financing. Of the total estimated cost of Rs. 7.0 million, as much as Rs. 5.0 million was to be raised by mortgaging owners' lands and Rs. 2.0 million from personal contributions. Nearly Rs. 2.1 million had been spent already. It was estimated that the entire cost would be recovered within three years of the completion of the project. The Commission feels that efforts should be made to encourage more such Societies to facilitate the scientific development of agricultural land.

1.32 The State Government has formulated a new scheme for providing lift irrigation to about 22,660 hectares on the Left Bank Canal which passes through the drought affected areas of Telangana. We are of the opinion that since water in this area is scarce, it should be used to the maximum extent possible to irrigate only crops which require light irrigation, instead of irrigating only paddy. There is no reason why, with proper irrigation, high-yielding varieties of crops like jowar, bajra, and groundnut should not be as paying to the farmer as paddy.

1.33 The introduction of large scale irrigation in the Nagarjunasagar ayacut can be expected to materially change the ground water situation there. There is almost certain to be a rise in the level of ground water and this calls for the systematic observation of all wells in the Canal command, so that whenever, and wherever, necessary, the optimum conjunctive use of ground water and surface water can be made. This will imply the maintenance of comprehensive and accurate records of observations from wells. We would recommend that such observations be made, on systematic basis, and that records be kept.

The Nizamsagar Project

1.34 The problem caused by the rapid silting up of the Nizamsagar reservoir was brought to our attention. It appears that when the dam was

completed, the storage capacity was 843 m.cu.m., but exceptionally heavy silting has more than halved this capacity, which is now only 403 m.cu.m. Obviously, this presents a problem of the first magnitude, because unless the rate of silting can be reduced the dam is doomed to premature extinction. We were informed by the representatives of the State Government that a scheme to put a dam at Sindhanur, upstream of the Nizamsagar Dam was being investigated. The State Government considers that this dam would drastically reduce the inflow of silt into Nizamsagar. We were also informed that the State Government was not in favour of allowing the construction of a large number of tanks in the catchment of the Nizamsagar reservoir to arrest the flow of silt into the reservoir, because of its apprehension that the construction of these tanks might reduce the flow of water into the reservoir. We are of the view that since the live storage capacity of the dam has already been drastically reduced by siltation, and is likely to be progressively reduced in the future, the reservoir cannot take as much water as before and for this reason, perhaps, the apprehensions of the State Government are unjustified. We would recommend that the State Government should reexamine the question, to assess the value of constructing tanks in the catchment.

We are aware that the problem of arresting the silting up of the Nizamsagar reservoir cannot be satisfactorily solved by measures confined to Andhra Pradesh, since the catchment of the reservoir extends into the territory of Maharashtra and Mysore. An effective scheme would need a high degree of cooperation between the authorities responsible for soil conservation in all three States. The catchment of Nizamsagar is covered by the scheme for soil conservation in river valley catchments, sponsored by the Central Government. The work is, however, proceeding slowly and we would urge that the pace be accelerated so as to complete the treatment of the catchment within ten years.

We would recommend that a Technical Committee be constituted by the Central Government, to coordinate the soil conservation operations in the three States concerned, to control sedimentation in the Nizamsagar reservoir. We are sanguine that the three States concerned will have no difficulty in evolving a mutually satisfactory scheme for prolonging the life of the Nizamsagar reservoir.

Tungabhadra Project and Kurnool Cuddapah Canal

1.35 The Tungabhadra Project was designed, like many other projects, to give continuous day and night irrigation. Night irrigation in rice fields, where water flows from the upper to lower fields, offers no special problem. The Commission was, however, informed that farmers growing light irrigated crops, who have to regulate and personally supervise the flow of irri-

gation at night, were not using water during the night hours and that water was going waste. The situation was sought to be remedied by putting up separate outlets for heavy and light irrigation, the former to operate at night and the latter in the day time. We were told that this arrangement has failed to solve the problem. The Commission recommends that the State Government should examine if the 'Warabandi' system of the north could be introduced with advantage in areas where night irrigation is not practised. Rosters allocating hours and days during which the farmers under an outlet would be permitted to draw water, should be fixed. In preparing the roster, care should be taken that farmers should, as far as possible, get day and night irrigation by rotation. Farmers who fail to make use of the allocated water would not be eligible for water out of turn.

1.36 In these areas, black soils are generally located in the valleys and the lighter red soils at higher levels. As it was feared that paddy grown on black soils would lead to waterlogging and salinity, these soils were localised for lightly irrigated crops and the red soils for wet crops needing heavy irrigation, i.e., for paddy and sugarcane. The red soils are lighter in texture and have greater permeability. Paddy grown on these soils consumes comparatively more water because of the greater percolation losses, but it also results in heavy seepage, which affects the black soils lower down, making it difficult for farmers to raise light irrigated crops on them.

Research at the Agricultural Research Station at Siruguppa in the black soil region shows that the cultivation of paddy and light irrigated crops from 1937 onwards had not led to the development of salinity. It has been proved that, with proper drainage, these soils are, indeed, more suitable for paddy, as they have low permeability and require less water. Paddy should, therefore, be localised, as far as practicable, on the heavier black soils which are situated at lower levels in the valley and the higher red soils should be reserved for light irrigated crops.

The Commission received complaints about the inadequate supply of water in the tail reaches of the Tungabhadra Low Level Canal. It was observed that whereas a duty of 160 acres had been assumed in respect of irrigated dry crops, only about half of this duty could be realised. Moreover, the cropping pattern, which actually emerged in the ayacut was different from the one assumed as it was not regulated. It is, therefore, necessary that duties in future should be fixed on a more realistic basis and the crop pattern is regulated.

1.37 The peculiar problems of the drought affected areas have been dealt with in previous paras. We were interested to see, for ourselves, what steps were being taken by the State Government to deal with them. We were happy to note that a large scale programme for constructing wells

and tanks and of soil conservation was in hand in places which we visited. However, it struck us that instead of employing outside labour on building field bunds, as is being done at present, the Soil Conservation Department would do well to encourage owners and occupiers of fields affected by the programme to do this work for wages. This approach has been very successful in Maharashtra. We would recommend its adoption by the Andhra Pradesh Government, so that all able-bodied persons including farmers, in any area where the programme is being carried out, can be mobilised.

At Anantapur, the Commission met a group of French Experts and local officers working on a pilot project for demonstrating moisture conservation techniques. Their approach was to take advantage of the local rainfall pattern. They had analysed the rainfall data for the last 50 years and had found that there were two spells of rain in the months of May and June, and another spell later in August and September. They proposed to utilise the rainfall in May and June for growing a crop of pulse, say, moong, as green manure. This would then be ploughed into the soil and a crop of jowar or bajra could be raised by taking advantage of the rainfall during August-September. They hope that this technique would improve the soil and give good crops. Other techniques adopted by them included land-levelling and field bunding.

A scientific quantitative and qualitative assessment of the ground water is essential in drought affected areas. We were glad to learn that the State Government has recently entrusted the task to the Geological Survey of India.

The State should also have an agency, fully equipped with boring machines, rock-blasting units, etc., to advise and assist farmers who undertake drilling of tubewells, boring/deepening of wells and the construction of small percolation or storage tanks. The Agro-Industries Corporation should be in a position to establish such a unit for the drought areas for this work. Wherever this is not possible, a separate Area/District Development Agency may be set up for the purpose.

The Use of Krishna Waters

1.38 A number of farmers in the districts of Kurnool and Cuddapah represented to us, that some of the Krishna waters, impounded by the Srisailam Reservoir could be utilised to irrigate their holdings in these districts. They stated that the feasibility of the idea had been established by the fact that the former State of Madras had at one time intended to irrigate areas in these very districts through the Krishna-Penner Project. They urged that since the Penner carried very little water, except in flash floods, the only reliable and adequate source of water for these areas was the Krishna which carries a sizeable surplus of water in some years over the

dependable flows normally utilised for irrigation. The flow between 75 per cent and 50 per cent dependability is of the order of 5,740-8,615 m.cu.m. and we see no reason why the States concerned should not agree among themselves to share the less dependable flows to irrigate chronically drought affected areas. If the Kurnool-Cuddapah areas get some of this water it might be possible to grow one good crop, at least once every two years. This water would usually be available at peak flood levels and we would recommend that the State Government should plan to store these flood flows at various places in the Kurnool and Cuddapah districts for subsequent use. These flows could even be used or stored in the shape of ground water, by water harvesting techniques. We would recommend that the Centre and the State should examine the possibility of using some such techniques for recharging ground water aquifers in the area.

Field Channels

1.39 The question of the responsibility for constructing and maintaining field channels to develop the ayacut is one which affects all irrigation projects. In Andhra Pradesh, the construction and maintenance of field channels is, at present, the responsibility of individual farmers. The State Government has the power to construct the channels, if and when the farmers fail to do it, and can recover the cost from the latter. However, the financial implications and the administrative work involved in doing this for any significant number of holdings is considerable. At a meeting held by us with the State Government officials at Hyderabad, the suggestion was made that in view of the fact that complete ayacut development was dependent on the construction of field channels, it would be advisable for the Government to arm itself with statutory powers to construct field channels as part of the project work, and to recover the cost as an addition to the water rate, or as part of the betterment levy. We are of the opinion that the suggestion is sound and recommend that the necessary legislation should be enacted. The Mysore Government has already enacted legislation on these lines.

Minor Irrigation

1.40 Nearly 46 per cent of irrigation in the State (1968-69) is from tanks and wells. The total number of wells is reported to be 484,000. It was brought to our notice, particularly at Srikakulam, Visakhapatnam and Anantapur, that a number of tanks have fallen into disuse because they had not been properly maintained. Some of these tanks were zamindari tanks, and with the abolition of zamindari, had ceased to be maintained. The obligation to maintain and repair them has fallen on the State. Unfortunately, some of these tanks have actually been taken over by the State

and the remainder are nobody's responsibility. Even with regard to those which had been taken over, there were complaints of delays in restoring and renovating them. We were given to understand that in the Fourth Plan the Government proposes to lay more emphasis on the development of minor irrigation, and progressively larger sums would be allocated for the programme. While we recognise that it is important to construct new tanks, we feel that it would be wrong, in principle, to allow existing tanks to fall into disrepair and eventually to go out of use. We would recommend, therefore, that the State Government should undertake a comprehensive programme for the restoration and renovation of old tanks throughout the State. We would also recommend that a time, bound programme should be worked out so that its progress can be watched.

At present, a sum of Rs 8.65 per hectare (Rs. 3.50 per acre) is allowed for the annual maintenance and repairs of tanks and channels. We were given to understand that, largely owing to the increased cost of labour and materials, the provision had become inadequate, and the State engineers were reported to have already proposed that the rate should be raised to Rs. 14.80 per hectare (Rs. 6/- per acre). We feel that there is considerable force in the proposal and recommend that the State Government should examine it and take suitable steps to enhance the provision. With regard to tanks, a suggestion was made to us at Kurnool and Anantapur that a large number of tanks within the command of the K.C. Canal and the Tungabhadra Canal could be filled when these canals are flowing. We were given to understand that these tanks are not eligible to get canal water. In years of deficient rainfall, these tanks dry up, and since they cannot be filled from canals, lands below the tanks suffer heavily. If our suggestion for the lining of canals, particularly, in drought affected areas, is adopted, it should be possible to save enough water to fill these tanks from the canals.

CHAPTER II

ASSAM, MEGHALAYA AND MIZORAM

It is only recently that the new State of Meghalaya and the new Union Territory of Mizoram have been formed by reorganising the old State of Assam. As all the statistics available pertain to the State of Assam before reorganisation, we have dealt with the States of Assam and Meghalaya and the Union Territory of Mizoram together.

These States form the easternmost part of India and are bounded by Bhutan and Arunachal Pradesh on the north and north-east, by Nagaland, Manipur on the east and south and by Tripura, West Bengal and Bangladesh on the west. They cover a total area of 121,966 sq.km. which represents approximately 3.72 per cent of the land surface of India. By virtue of their situation, the States form the core of the entire north-eastern region of the country and all lines of communication for the surrounding areas pass through them.

According to the 1971 census, the population in the area was 14.95 millions living in 80 towns and 25,702 villages. The density of population was 150 per sq. km. against the all-India average of 182.

Agriculture is the main occupation of the people, of whom nearly 91.6 per cent live in villages which are generally small. Working hands number 4.28 millions or 28.63 per cent of the population, and 2.82 millions are engaged in agriculture.

2.2 Though the States receive heavy rain extending over eight months in the year (March to October), some parts at times require irrigation to grow good crops. Irrigation before Independence was chiefly through minor works, such as diversion weirs. Water was tapped from small streams and utilized for irrigating nearby areas. The commands were generally small, and the diversion works were temporary in nature. Irrigation was not assured, and at times the streams went dry even during kharif. Whenever there was a long dry spell, the crops were left to the vagaries of the monsoon.

During 1950-51, an area of 0.55 million hectares was served by this kind of irrigation out of a total cultivated area of 2.56 million hectares. During the Plan periods also, the main emphasis has been on minor irrigation,

though Assam has executed two medium schemes. The Jamuna irrigation scheme (completed in 1969) provides irrigation to a gross area of 34,060 hectares and the Patradisha (also completed in 1969) is meant to provide irrigation to a gross area of 2,430 hectares.

Physiography

2.3 The area has two physio-geographical divisions almost equal in size. One is the hills region, roughly comprising the four administrative districts of the United Khasi and Jaintia Hills, the United Mikir and North Cachar Hills, the Garo Hills and the Union Territory of Mizoram. The second consists of the plains comprising the six districts of the Brahmaputra valley, namely, Kamrup, Goalpara, Nowgong, Sibsagar, Darrang and Lakhimpur, and the Cachar district of the Barak valley. The concave shaped Brahmaputra valley is for the most part an extensive plain. The Barak valley is separated by the Khasi and Jaintia Hills and the Mikir and North Cachar Hills. Out of the total area of nearly 122,000 sq. km., 63,000 sq. km. form the plains, and 59,000 sq.km. are in the hills.

The plains are traversed by the Brahmaputra and its tributaries in the north, and the Barak and its tributaries in the south. These mighty rivers along with their tributaries, which discharge the run-off from the high rainfall in the State, account for the devastating floods which are an annual feature. Large areas are periodically inundated, and considerable tracts of land are eroded and washed away, so that many important riverine towns suffer damage year after year. The total damage by the floods during the 14 years from 1954 to 1967 has been estimated to be Rs. 1070 million, averaging Rs. 77 million a year.

Soils, Climate and Rainfall

2.4 The Brahmaputra valley is covered with coarse alluvium. Due to heavy rain and the steep slope, the soils are leached and in consequence acidic. The fresh alluvium on the river banks is less acidic, being often neutral and even alkaline. In the upper valley where tea is grown, the phosphoric content of the soil is high though it is low in the lower reaches of the valley. There is generally sufficient nitrogen and organic matter, particularly in the low-lying soils. The soils in the valley are suitable for the production of rice, jute, sugarcane and tea.

The Cachar valley has finer alluvial soil, and is characterized by an abundance of marshes and lakes, the soils of which contain a large proportion of organic matter, suitable for growing rice, jute and other crops.

The red loams and lateritic soils of the hills are more acidic than those of the plains, and contain a high proportion of nitrogen and organic matter,

which make them suitable for horticulture. Rice is also grown on the terraces and in the valleys.

2.5 The climate, with local variations, is tropical. The maximum temperature between July and September is around 30 to 32°C in the plains, and 20 to 24°C in the hills. The temperature during the winter is 8 to 10°C in the plains, and 3 to 4°C in the hills. January is the coldest month of the the year. Because of the tropical climate, humidity is quite high, ranging from 70 to 85 per cent.

2.6 The States get very heavy rain, and Cherrapunji on the Shillong plateau, which is said to have the highest rainfall in the world, receives about 11,430 mm per annum. The rainfall varies between 1,000 and 4,060 mm (40 and 160 inches). There are pockets of heavy rainfall at either end of the Brahmaputra valley, though the southern flank of the valley is, to some extent, in the rainshadow.

Unlike the rest of India, the rainfall is generally spread over a period of eight months, i.e. from March to October. From May to October, the States get both monsoon and cyclonic rain, and about 90 per cent of the total precipitation occurs in these months. The winter season from December to March is practically dry.

The general rainfall pattern is suitable for the growing of paddy, jute and tea, and it is possible to raise three successive crops from the same land if the fertility of the soil is maintained. Sometimes, however, the advent of the south-west monsoon is delayed, and this adversely affects the sowing of kharif paddy. When the monsoon terminates much earlier than usual, it causes damage to the kharif crops, and makes the sowing of winter crops uncertain and difficult. Occasionally also, there are prolonged breaks in the monsoon which affect the kharif crops.

Land Use and Cropping Pattern

2.7 Table 2.1 shows the land utilization statistics in the States for the year 1968-69:

It is seen from the table that the net sown area is less than 20 per cent of the reporting area, while forests and land not available for cultivation (being either barren or put to non-agricultural use) account for more than 72 per cent of the total area of the State.

Principal Crops

2.8 Rice is the most important crop followed by tea, oil seeds and jute.

Table 2.1*

Land Use Details

Classification	Area (Thousand hectares)	Percentage of reporting area
1	2	3
Geographical area	12,210	
Reporting area	12,154	100.00
Forests	3,565	29.4
Land not available for cultivation		
(a) Area put to non-agricultural use	768	6.3
(b) Barren and uncultivated land	4,459	36.7
(c) Total	5,227	43.0
Other uncultivated land excluding fallow land		
(a) Permanent pastures	234	1.9
(b) Land under misc. tree crops and groves not included	228	1.9
(c) Cultivable waste land	184	1.5
(d) Total	646	5.3
Fallow land		
(a) Fallow lands other than current fallows	173	1.4
(b) Current fallows	129	1.1
(c) Total	302	2.5
Net sown area	2,414	19.8
Total cropped area	2,962	
Area sown more than once	548	
Net irrigated area	612†	
Gross irrigated area	612†	

**Source:* Indian Agriculture in brief—Economics and Statistics Directorate, Ministry of Agriculture, Eleventh Edition.

†Relates to the year 1953-54.

During 1968-69, the area under food crops was 82.2 per cent of the total cropped area. Table 2.2 shows the area under different crops during 1968-69.

The difference in terrain has naturally led to different cropping patterns in the hills and in the plains. In the hills, the practice of jhum or shifting cultivation is followed on steep hill slopes, due to the scarcity of flat land and the difficulty of terracing the slopes. In the plains, there is 'settled culti-

Table 2.2*

Areas under Principal Crops

Crop	Area (Thousand hectares)	Percentage to total cropped area
1	2	3
Rice	2,087	69.6
Maize, wheat and other cereals	40	1.3
Total cereals & millets	2,127	70.9
Pulses	91	3.0
Total foodgrains	2,218	73.9
Sugarcane	32	1.1
Condiments & spices	50	1.7
Fruits	55	1.9
Vegetables	112	3.8
Other food crops	7	0.2
Total food crops	2,474	82.6
Oil seeds	151	5.3
Cotton	17	0.6
Jute	111	3.7
Mesta	8	0.3
Tobacco	10	0.3
Tea	177	6.0
Fodder and other non-food crops	14	0.1
Total non-food crops	488	16.4
Total cropped area	2,962	100.0

**Source*: Ministry of Agriculture, Economics and Statistics Directorate.

vation'. Paddy is the major crop and 69.6 per cent of the total cultivated area is under it. Tea is the major plantation crop, and the area under this crop (6 per cent) is next only to paddy. Jute (3.7 per cent) and sugarcane (1.1 per cent) are the most important cash crops. Oilseeds (5.3 per cent) and pulses (3 per cent) are also grown in the plains. Of late, wheat also is being grown in Assam and it is expected that with assured irrigation it can become one of the principal crops.

In the Khasi and Jaintia hills, potato is a major crop. Rice, millets, maize and tubers are cultivated on hill slopes (Jhum cultivation). High-altitude paddy is also being introduced in some areas. Oranges, pineapples and bananas constitute the important crops of the hill regions, and are grown over large areas.

Surface Water Resources

2.9 The two principal river systems which drain Assam, are (*i*) the Brahmaputra, and (*ii*) the Barak.

Brahmaputra River System

The Brahmaputra with a total length of 2,900 km. and a catchment area of 0.94 million sq.km. is one of the biggest rivers in the world. It rises at Tamchok Khamdat Chorten in the Chemayung-dung glacier. It has a long course through the comparatively dry and flat region of southern Tibet, before breaking through the Himalayas below the peak of Nancha Barwa. It is known as the Dihang in the Assam Himalayas before it enters the plains. The Dibang and the Lohit join the Dihang from the east near Sadiya. The Dibang drains the Himalayas east of the Dihang, while the Lohit drains an area between Assam and Burma. After traversing the Assam Valley for 720 km., the Brahmaputra sweeps round the Garo hills and enters the Rangpur district of Bangladesh. A number of tributaries drain into the Brahmaputra from north and south, in its course through the State.

Of the 25 principal north bank tributaries, the Subansiri, the Jia-Bhareli and the Manas are fairly large rivers with maximum recorded discharges of 11,377 cumecs, 5,886 cumecs and 7,641 cumecs respectively. The discharges in the Ranganadi, the Dikrong, the Dhansiri, the Pagladiya, the Aie, the Champamati and the Sankosh are almost as high. The north bank tributaries are generally large, since their catchments lie in the heavy rainfall zone of the Himalayas. The main characteristics of these tributaries are that they have very steep slopes, and flow through shallow braided channels for a considerable distance from the foot hills and in some cases right up to the outfall. They have coarse sandy beds and a heavy silt charge, and are subject to flash floods. The volume of discharge in these tributaries, even within the monsoon period, is subject to wide variations.

The south bank tributaries of the Brahmaputra in the State are generally smaller than those of the north bank, as their catchments in the Assam hills are smaller and get less rain. They have comparatively flatter grades, high meandering channels almost from the foot-hills, beds and banks of alluvial soil, and a comparatively low silt charge. There are 15 principal south bank tributaries, the most important among them being the Buri-Dehing, the Kopili and the Dhansiri.

The average annual run-off of the Brahmaputra at Pandu is of the order of 487,225 m.cu.m. Adding to this the run-off of the principal tributaries which meet the Brahmaputra downstream of Pandu, the run-off of the whole Brahmaputra river system may be taken to be 558,766 m.cu.m.

Low-lying pockets known locally as 'beels', and old tanks are scattered

in fair numbers all over the Brahmaputra valley and are good sources of irrigation.

Barak River System

The Barak rises on the southern slopes of the mountain range to the north of Manipur. Its upper reaches are marked by steep banks and several falls. It turns west as it flows through the Cachar district and joins the Meghna in Bangladesh.

The length of the Barak from its source to the international border is 560 km. The total length of the river up to the outfall at Meghna is 900 km. It has a catchment area of 25,900 sq.km. up to Badarpur. At Lakhipur the maximum recorded discharge is 15,122 cumecs and the average annual run-off is 18,749 m.cu.m. It has numerous tributaries within Assam joining it from the north and the south. The principal north bank tributaries are the Chiri, Madhura, Larsing, Harnag and Badri. The principal south bank tributaries are the Amjur, Rukni, Sonai, Dhaleswari, Singla and the Lengal.

The annual run-off of the Barak and its tributaries within the State is about 32,677 m.cu.m.

There are a large number of extensive low-lying water pockets scattered all over the Barak valley like the 'beels' of the Brahmaputra valley known locally as 'haors'. These are also good sources of irrigation.

The water resources in both these systems are plentiful and perhaps more than can be utilised in the near future. The Brahmaputra and the Barak river valleys, discharge enormous quantities of water and cause extensive flooding over wide areas of cultivable land.

The following table shows the percentage of yields in various rivers during different periods of the year.

Ground Water Resources

2.10 Taking into account the heavy rainfall, it can safely be assumed that the ground water resources in Assam are considerable and there is scope for utilising them for irrigation.

In the Brahmaputra valley there are good possibilities of utilising ground water for irrigation. Irrigation from ground water sources would be more dependable than diversion works on small streams. Ground water exploitation is, however, more expensive and would have to be justified by the economic returns from the crops. To ascertain the feasibility of sinking deep tube-wells in the area, the Exploratory Tube-wells Organisation began drilling, in 1960, in the four districts of Kamrup, Nowgong, Sibsagar and Darrang. Twentytwo successful deep tube-wells have been drilled by this

Table 2.3*

Season-wise Yields of Rivers

Name of river	Percentage of yield				Year for which average worked out
	June-Sept.	Oct-Dec.	Jan.-March	April-May	
1	2	3	4	5	6
Brahmaputra (at Pandu)	67.0	15.0	5.5	12.5	1956 to 1962 1966 to 1968
North Bank tributaries					
Subansiri (Bhimpura ghat)	62.0	13.5	7.0	17.5	1956-58
Manas (Mathanguri)	63.5	18.0	7.5	11.0	1956-60
Aie (Rly. Bridge)	76.0	13.0	5.5	5.5	1960-66
Pagladia (N.T. Road crossing)	80.0	11.5	4.2	4.3	1956-66
South Bank tributaries					
Buri-Dehing (Khowang)	70.0	11.0	4.0	15.0	1956-58
Dhansiri (A.T. Road crossing)	70.0	17.5	4.0	8.5	1956-59 1964-66
Kopili	63.0	16.5	5.5	15.0	1955-58 1962, 1965, 1966
Barak System					
Barak	67.0	21.5	3.5	8.0	1961-64

*State's replies to Irrigation Commission Questionnaire.

organisation—four in Kamrup, five in Nowgong, six in Sibsagar and seven in Darrang. The aggregate gross commanded area of these tube-wells is 1,370 hectares.

Present Stage of the Development of Irrigation

2.11 Before 1951, the Agriculture Department helped cultivators who had put up small diversion works, by sharing the cost of such works and by providing technical guidance. In the northernmost region, comprising the districts of Darrang, Kamrup and Goalpara, the cultivators have tapped a number of rivers in the foot hills to feed their 'dongs' (irrigation channels)

by constructing small boulder-bunds across them. In the central regions of these districts, the bunds across the streams were of earth or of a composite section of earth and brush wood. These arrangements were necessarily temporary in nature as the channels were quickly eroded and went out of use. The bunds were washed away with the rise in the water levels of the streams.

During 1950-51, the irrigation practised by these means was 0.55 million hectares, nearly 20 per cent of a total cultivated area of 2.56 million hectares.

In the post-Independence period, too, many minor irrigation schemes were taken up. Of these, 67 have been completed (56 in the Brahmaputra Valley and 11 in the hills) and 17 are in progress. The completed schemes irrigate about 82,000 hectares. The minor diversion schemes in the Brahmaputra valley are generally based on the run-of-the-river. The lift irrigation schemes in the hills draw water from running rivers and streams. They were executed by the P.W.D. (Irrigation and Flood Department). Some diversion as well as lift irrigation schemes were also executed by the Agriculture Department with the beneficiaries contributing at varying rates. Lift irrigation schemes included the supply on a hire-purchase basis of pumpsets of 5 to 40 H.P. With these efforts, an irrigation potential of 0.51 million hectares had been created up to the end of 1968-69. However, most of the irrigation potential created by these schemes is of a very temporary nature and cannot be expected to provide assured irrigation even for the kharif crop, as the streams being tapped are very small, with fluctuating discharges. For all practical purposes, therefore, the assured irrigated area, even for the kharif crop can be assumed to be only 25 per cent of the total figure of 0.51 million hectares. In other words the assured irrigation is only 0.13 million hectares. The minor schemes which we have been describing provide very limited irrigation for the rabi crop. The irrigation potential for the rabi crop created by lift irrigation schemes to the end of 1968-69 is estimated at about 2,000 hectares.

2.12 No major or medium irrigation projects were taken up in the States during the First and the Second Plans (1951-61). Only in the later part of the Third Plan were the following medium projects taken up.

(*i*) The Jamuna
(*ii*) The Sukla
(*iii*) The Patradisha and
(*iv*) The Longa

Jamuna Project

The project envisages a weir 354 m long across the Jamuna river, near Bakuliaghat in the Mikir hills to benefit areas in the Mikir hills and in the

Nowgong district. Work on the project started in 1964 and was completed in 1969. The estimated cost of the project was Rs. 39.6 million and the gross area to be benefited was 34,060 hectares, the net area being 25,600 hectares. During 1969, the entire area of 25,600 hectares was irrigated during the kharif season.

Sukla Project

The project envisages a weir across the Sukla river near Naokota. On completion, the project will provide irrigation to 32,640 hectares in Kamrup district. Work on the project started in 1965 and is expected to be completed in the Fourth Plan. The estimated cost of the project is Rs. 29.8 million.

Patradisha Project

The Patradisha project has been taken up to provide irrigation in the tribal areas of the Mikir hills. It consists of a weir across the Patradisha (a tributary of the Jamuna) and a canal system to irrigate 2,430 hectares—1,620 hectares in kharif and 810 hectares in rabi. The project is estimated to cost Rs. 3.36 million. The work was started in 1965 and completed in 1969. An area of 1,620 hectares was irrigated during the kharif season of 1969.

Longa Project

The Longa project envisages a weir across the Longa river in Goalpara district. The project, estimated to cost Rs. 6 million will provide irrigation to 4,869 hectares. Work has yet to be started.

The Assam Government has also undertaken the Harguti irrigation scheme to irrigate annually 4,430 hectares—2,590 hectares in kharif and 1,840 hectares in rabi—in the hill districts. The scheme which envisages a barrage across the river of the same name, and a left bank canal system, is estimated to cost Rs. 4.28 million. The work was started in 1968-69 and is expected to be completed during the Fourth Plan period.

Expenditure under the irrigation programme till 1968-69 was about Rs. 42.5 million for the plains and Rs. 3.33 million for the hills. The net irrigated area in the Brahmaputra valley and in the hills under the minor, major and medium irrigation programmes executed by the P.W.D. (Flood Control and Irrigation) to the end of 1968-69 was 105,000 hectares and 4,400 hectares respectively.

Drought Affected Areas

2.13 Although Assam has an abundant rainfall, it is not immune from

the vagaries of the monsoon. There are a few areas where drought sometimes occurs. In Nowgong and the Mikir Hills Districts, that portion of the Kopili basin lying north of the hills and drained by the Jamuna river constituted the drought-affected region. However, with the completion of the Jamuna Irrigation Project, the area is well served with irrigation. A few other schemes have either been completed or are under execution there. Investigations for some more minor irrigation schemes are also in progress. The achievement in irrigation in this region to date is 29,300 hectares of the net irrigated area. On the completion of the schemes in hand, this figure will rise to 33,700 hectares and will cover most of the drought-affected areas.

A part of the Dhansiri river basin from the foothills in the south of Barpather, partly within Sibsagar district and partly within the Mikir Hills district is also a drought-affected region. No irrigation scheme has yet been taken up here, though some are under investigation.

The northernmost region on the north bank of the Brahmaputra covering the Mangaldoi Sub-Division of Darrang district, and the Kamrup and Goalpara districts, though not deficient in rainfall, has very porous soils where no crop can thrive without irrigation. For this reason, some minor irrigation schemes have been taken up and others are under investigation. A part of the commanded area of the Sukla Scheme in Kamrup district, which is under construction also falls in this belt. In Darrang district, the Dhansiri Scheme which is a major project, and two medium irrigation schemes, namely, the Phulaguri in Darrang and the Pagladiya in Kamrup, are now under investigation.

Future Irrigation Possibilities

2.14 The necessity to introduce extensive multiple cropping and the inadequate rainfall during the winter months, both call for an expansion of irrigation. The Assam Government is of the view that even if 60 per cent of the present net cropped area in the plains, measuring 2.07 million hectares, can be given irrigation, the ultimate irrigable area would be 1.24 million hectares. We consider the estimate to be reasonable in view of the fact that the Assam plains are covered by a network of rivers with an abundant potential for irrigation.

The net cropped area of the hill districts is 0.27 million hectares. No physical assessment of the ultimate irrigable area here has been made, but in view of the difficulties in the way of providing irrigation, the ultimate irrigable area may be estimated at 25 per cent of the net cropped area, which works out to 0.07 million hectares.

Thus, the estimated ultimate irrigable areas in the plains and in the hill districts are as follows:—

(a) Plains	1.24 million hectares
(b) Hills	0.07 ,, ,,
Total:	1.31 million hectares

The net irrigated area to the end of the year 1968-69 as reported by the State Government is as follows:—

(a) Plains	(i) By Public Works Department (Flood Control & Irrigation)	0.11 million hectares
	(ii) By the Agriculture Deptt.	0.12 ,, ,,
	Total:	0.23 million hectares
(b) Hills	(i) By Public Works Deptt. (Flood Control & Irrigation)	0.004 million hectares
	(ii) By the Agriculture Deptt.	0.007 ,, ,,
	Total:	0.011 million hectares
	Grand Total:	0.24 million hectares

The balance of area to be irrigated in the Fourth and subsequent Plans would be:

(a) Plains	1.02 million hectares
(b) Hills	0.06 ,, ,,
Total:	1.08 million hectares

Taking the average capital cost of irrigation at Rs. 1,250 per hectare in the plains, the total financial implications of bringing 1.02 million hectares of land under irrigation would be Rs. 1,253 million. The cost of irrigation in the hills is naturally much higher than in the plains and a figure of Rs. 2,250 per hectare would be reasonable. Bringing 0.06 million hectares of land under irrigation in the hills would cost Rs. 123.3 million.

Thus, the total capital investment on irrigation in Assam from the Fourth Plan onwards may be put at Rs. 1,380 million at current prices.

(The names of schemes and details to implement this programme have however not been given by the State).

Floods, Waterlogging and Drainage

2.15 The heavy rainfall (2,480 mm to 6,350 mm) in the riverine areas of the narow Brahmaputra and Barak valleys is concentrated in a period of five months. This, coupled with the fact that 73 per cent of the area of the State comprises hills, makes Assam particularly susceptible to floods.

The total width of the Brahmaputra valley in the foot-hills is only 80 to 90 km, of which the river itself has a width of 6 to 10 km. In most places, forests extend for a few km along the foothills. Tea gardens in certain districts occupy a substantial portion of the higher area. The remaining width of the valley in which are situated the villages and cultivated fields, is very narrow. Similarly, the width of the Barak valley between the foothills is only 40 to 50 km and the area is dotted with low-lying pockets of land called 'haors'. The rest of the area is covered by tea gardens, villages and cultivated fields. During the floods the problem of saving life and property in these narrow strips assumes formidable proportions.

The area is subject to severe and frequent earthquakes which cause numerous landslides in the hills and often upset the regime of the rivers. After the great earthquake of 1950, the bed of the Brahmaputra rose by about 3 m at Dibrugarh in about 10 years and to varying extents in the other reaches also. This has naturally aggravated the already serious flood problem of the State.

The history of floods in the valleys shows that there is no regular cycle for their recurrence. Floods during the last decade have been heavier than in the preceding decades. The years 1931, 1935, 1948, 1949, 1954 and 1962 were years of high flood in the Brahmaputra valley. The Barak valley experienced high floods in 1913, 1915, 1916, 1929, 1938, 1946, 1948, 1951, 1959 and 1962. The year 1929 flood was the highest within living memory, in the entire basin.

The details of the flood damage in the area during the period 1954-63 are given below:

Table 2.4

Flood Damage

Year	Frequency	Area affected sq. km.	Property damage Rs. million
1954	Once	31,469	159
1955	Once	13,912	43
1956	Once	5,991	47
1957	Once	3,958	45

Table 2.4—contd.

1958	Once	12,443	27
1959	Once	10,253	84
1960	Once	4,735	86
1961	Once	1,937	9
1962	Twice	15,781	145
1963	Twice	5,825	30

The flood protection work done so far is indicated below:—

(i) Embankments	3,630 km.
(ii) Drainage Channels	730 km.
(iii) Area benefited	327,807 hectares
(iv) Town protection works	20 Nos.
(v) Expenditure	Rs. 185.6 million

2.16 A draft Master Plan for flood control in Assam has been prepared. The measures proposed in it are expected to benefit a substantial additional area of about 0.76 million hectares at a cost of Rs. 600 million (1964 price level). The proposals for a long term solution of the flood problem as outlined in the draft Master Plan are summarised below:—

	(Rs. million)
(i) New embankments	96.66
(ii) Raising and strengthening of existing embankments	46.43
(iii) New drains	22.63
(iv) Sluices in embankments	20.72
(v) Town protection and antisea erosion works	86.56
(vi) Multipurpose reservoir and flood detention basins	275.05
(vii) Other works	48.93
(viii) Total estimated cost	596.98
	say Rs. 600.00 million

The Master Plan is under revision and the total cost may be higher than Rs. 600 million.

Financial Aspects, Water Rates and Betterment Levy
Water Rates

2.17 Water rates are recoverable according to Section 11 of the Assam Embankment and Drainage Act, 1953 which lays down that

"For all works carried out under section 9, the State Government may, unless they decided otherwise in specific cases, levy on settled land an annual water rate or betterment cess and on unsettled Government waste land improved by the works, a premium payable on settlement of such land and an annual water rate or betterment cess so as to realise the initial cost of the scheme in full or in part and that of its maintenance in the manner as the Government may prescribe. The total annual water rate, betterment cess or premium to the levied under a scheme, shall be fixed as nearly as possible so as not to exceed the following limits:

(i) six per cent per annum on the first cost of the said works adding thereto the estimated yearly cost of maintenance and supervision of the same;

(ii) such rate may be varied from time to time;

(iii) any rate chargeable under the Act shall be termed either 'Water Rate' or 'Betterment Cess' as the case may be and shall be recoverable in the same manner as land revenues."

Betterment Levy

2.18 In any area in which a new canal has been provided, every permanent holder of land, whose land is benefited by such a canal is liable to pay to the State Government, annually, in respect of such land, a betterment contribution at a rate to be determined in accordance with the following formula:

(i) For the first five years from the commencement of the collection of levy:

$$Z=\frac{X}{Y}\times\frac{3}{100}$$

(ii) For the next 10 years:

$$Z=\frac{X}{Y}\times\frac{4.5}{100}$$

Where X is the total cost of construction.
Y is the area (in acres) benefited.
Z is the rate of betterment contribution per acre per year.

The total betterment charges on the basis of this formula were rather high, and in order to give relief to the beneficiaries, the State Government proposes to realize Rs. 285 per acre to be repaid over a period of twenty years.

So far, no betterment charges have been realized.

CHAPTER III

BIHAR

Though the ninth largest in size, Bihar with a population of 56.3 millions is the second most heavily populated State in India. It has 10.29 per cent of the country's population, while occupying only 5.30 per cent of its land area. It has a predominantly agricultural economy, and the 50.7 million people living in villages represent 90 per cent of the State's population. As many as 82 per cent of those living in villages are dependant on agriculture, while 60 per cent of the income of the State comes from the rural sector.

Bihar is endowed with good water resources, and apart from the Ganga, it has a number of major rivers flowing through it, among the biggest of them being the Kosi, the Gandak, the Ghaghara, the Son, the Damodar and the Subarnarekha. The principal crop is rice, though maize, wheat, gram and barley are also widely grown. Sizeable areas grow sugarcane, marwa, arhar, jute and linseed as well.

The Son canals were completed in 1875. It was the State's first major irrigation project. By the standards of the day, it was an ambitious project and benefited an area of 347,000 hectares. Nearly forty years later, in 1914, the Tribeni Canal which irrigated 48,000 hectares, was constructed. Both these canal systems have undergone extensive expansion, improvement and remodelling since they were first constructed, and the total area now irrigated by them is 431,870 hectares.

It was not till after Independence that major strides were taken in the field of irrigation. The Mayurakshi Left Bank Canal (1954), the Lower Kiul Canal (1956) and the Badua Reservoir were completed by the end of 1957, 1959 and 1969 respectively, and the Chandan Dam and the Rajpur Canal which were taken up for construction in 1958 and 1961 respectively, have made substantial progress. These are expected to be completed during the period covered by the Fourth Plan. Apart from these earlier works, new and much more ambitious ventures, with tremendous irrigation potential, have been taken up, particularly the taming of the Kosi, which has been called 'Bihar's river of sorrow', and the construction of a barrage at Valmikinagar on the Gandak. These two are multi-purpose projects and will benefit areas in Nepal, Uttar Pradesh and Bihar.

The Kosi Project is a multi-purpose project providing irrigation, power and flood control, while the Gandak Project provides irrigation through its canal system, and electricity from a power station situated in Nepal.

Physiography

3.2 The State of Bihar which covers an area of 17,388 thousand hectares, or 173,876 sq. km. is bounded on the north by the foothills of Nepal, on the west by the plains of Uttar Pradesh, on the east by West Bengal, and on the south by Orissa. The State can conveniently be divided into, (*a*) north Bihar comprising a portion of the alluvial plains of the Indo-Gangetic basin and watered by the Kosi, the Gandak and their tributaries, as well as by the Burhi Gandak, the Ghaghara, the Bagmati and the Mahananda; (*b*) south Bihar which comprises the flat alluvial plains bordering the Ganga and the area to the west of the Rajmahal hills and north of the Chhota Nagpur plateau and (*c*) the Chhota Nagpur and Kaimur plateaus.

The south Bihar alluvial plains cover the major portion of the districts of Patna, Gaya and Shahabad. Extensive alluvial areas also extend southwards to the Chhota Nagpur plateau. The area is drained by the Son in the west, and by a number of tributaries of the Ganga, like the Karamnasa, the Durgawati, the Pun Pun, the Batane, the Adri, the Morhar, the Sakri, and the Kiul.

The Chhota Nagpur plateau covers parts of the districts of Bhagalpur, Gaya, Patna and most of Hazaribagh, Palamau, Ranchi, Singhbhum, Santhal Parganas and Dhanbad districts. In this area, the major rivers are the Damodar, the Subarnarekha, the North and South Koel, the Ajoy, the Konar and the Barakar. These rivers are mostly non-perennial and drain the hard rock terrain typical of the area.

The Chhota Nagpur plateau is characterized by low hills, which form ranges in some areas, and by valleys and depressions filled by alluvial detritus. The very large flat Kaimur plateau forms a steep scarp towards the north-west.

3.3 Bihar is one of the most important States in India for minerals. The coal belts of Bihar which play a major role in the economy of the State, run from east to west in the three districts of Hazaribagh, Palamau and Dhanbad, and from north to south in the Santhal Parganas. The industrial potential of the State is being rapidly developed. The Fertilizer Plant at Sindri and the High Tension Insulator Factory at Ranchi are evidence of this development. Because of its enormous coal reserves, Bihar has great potential for the generation of thermal power, which from 244 MW in 1950 reached 767 MW in 1969. There are proposals to extend this potential considerably.

Soils

3.4 The sandy alluvial soils of the north Bihar plains are among the most fertile in India, and support a variety of crops. These soils are rich in lime and often contain a high proportion of clay. They are spread over the entire plains of north Bihar, with the exception of a portion of the mid-west which is calcareous and which contain a very high proportion of calcium carbonate.

The soils of the south Bihar plains consist of alluvium of heavy texture, with a heavy sub-soil. Highly ferruginous red soils cover almost the entire Chhota Nagpur plateau, with the exception of Singhbhum district. Variations exist due to differences in parent rock, temperatures, and the extent of leaching. Singhbhum and parts of south-east Ranchi have a mixture of red and black soils.

Climate

3.5 Generally speaking, the climate of Bihar is moist and warm, milder in the northern districts but with great extremes of temperature in the districts of Gaya, Shahabad and Patna. Rainfall is confined almost exclusively to the south-west monsoon period.

While the annual mean temperature varies between 24°C and 27°C, the maximum ranges between 40°C and 46°C, and the minimum between 4°C and 9°C. May is the hottest month with a mean temperature of 32°C. Temperatures at Gaya which is the hottest district, go up, in May to 46°C.

Rainfall

3.6 The south-west monsoon accounts for about 80 to 90 per cent of the annual rainfall in Bihar. Precipitation received during this period is in the range of 1000 mm. to 1200 mm. in the southern and northern-most districts, and 850 mm. to 1000 mm. in the area in between, comprising the districts of Patna, Monghyr, Bhagalpur, Saran and Shahabad. The annual rainfall also reflects this pattern. A peculiar feature of the rainfall in the State is that though the degree of variability in the south-west monsoon and annual rainfall is tolerable, the distribution of rainfall over the crucial months shows a high order of variation, particularly in the central zone. Several of the crop failures of the past can be ascribed to this factor.

The late September-October rains, locally known as 'Hathia' account for only a bare 5-10 cm. of the annual rainfall, but they are crucial to agriculture in the region. Their timing and distribution make all the difference between plenty and scarcity.

Table 3.1 illustrates features of the rainfall in Bihar over a period of 21 years at 51 recording stations.

Table 3.1

Rainfall in Bihar

Period	Highest rainfall in cm.	Lowest rainfall in cm.	Average rainfall in cm.	No. of stations having more than average rainfall	No. of stations having less than average rainfall
1	2	3	4	5	6
Monsoon period 16 weeks (18th June to 7th October)	165	74	102	17	34
Hathia 4 weeks (24th September to 21st October)	—	—	9.78	26	25
Rabi period 12 weeks (8th October to 31st December)	—	—	5.49	23	28
Winter rainfall 8 weeks (January to February)	8.03	0.91	4.06	—	25

Taking the average figures for the 16 weeks from June to October, over a period of 21 years, we find that roughly one-third (124 weeks) showed a rainfall above the weekly average, against two-thirds (212 weeks) which showed a heavier than average rainfall. The variation in difference ranged from above 50 per cent in 139 weeks to below 50 per cent in 72 weeks.

The frequent recurrence of famine and drought is explained by the rainfall pattern over the past 25 years which shows that the crucial 'Hathia' (September-October) rains fail once in every three years in south Bihar, once in every four years in north Bihar, and once in every five years in Chhota Nagpur. These statistics underline the critical importance of irrigation in Bihar as a means of protection against drought.

Land Use and Cropping Pattern

3.7 Table 3.2 gives the land utilisation statistics for Bihar* for the year 1968-69:

Table 3.2

Land Utilisation-Bihar

Item	Area (in thousand hectares)	Percentage to the reporting area
1	2	3
Total geographical area	17,388	—
Reporting area	17,330	100
Forests	3,008	17.4
Barren and unculturable land	1,035	6.0
Land put to non-agricultural uses	1,516	8.7
Culturable waste	559	3.2
Permanent pastures and other grazing lands	182	1.05
Land under miscellaneous tree crops and groves not included in the net area sown	182	1.05
Current fallows	1,590	9.2
Other fallow lands	933	5.4
Net area sown	8,325	48.0
Area sown more than once	2,573	14.9
Gross area sown	10,898	62.9
Percentage of net area irrigated to net area sown		26.1
Percentage of gross irrigated area to gross area sown		24.7

*According to village papers.

The area under principal crops are shown in Table 3.3

Table 3.3

Area under Principal Crops in Bihar—1968-69

Crop	Area in thousand hectares
1	2
Rice	5,407
Wheat	1,101
Barley	299
Marua (Ragi)	181
Maize	944
All cereals	8,198

Table 3.3—contd.

Pulses	1,624
Total foodgrains	9,822
Sugarcane	152
Chillies	22
Potato	111
Sesamum	33
Rape & Mustard	79
Castor-seed	6
Linseed	63
Jute	90
Mesta	23
Tobacco	14
All crops	10,898

Foodgrains occupy about 90 per cent of the total cropped area in the State. Among foodgrains, rice is the major crop and occupies about 50 per cent of the total cropped area. Bihar has 15.1 per cent of the area under rice and 11.8 per cent of the production of rice in the country (1967-68—1969-70). It ranks second among the rice-producing States. The other foodgrain crops grown are wheat, maize, barley and ragi.

Among non-foodgrain crops, sugarcane, potato, jute, linseed, rape and mustard are the major crops. Bihar ranks second in the country among the States growing jute and the area under this crop in the State is 12.4 per cent of the total area under the crop in the country.

Surface Water Resources

3.8 The Ganga enters Bihar near the town of Chapra where it is joined by the Ghaghara on its north bank. The area north of the Ganga is called north Bihar, while that south of it is known as south Bihar. The Ghaghara is a snow-fed river having its origin near Katomate in Nepal.

Between Chapra and Patna, the Son joins the Ganga from the south and the Gandak joins from the north. The Gandak rises in the snowy mountain basin of Nepal which is known as Sapt Gandaki, or the country of seven Gandaks. It flows through contiguous areas in the States of Uttar Pradesh and Bihar. The river falls into the Ganga opposite Patna. The Son rises in the Vindhya range in Madhya Pradesh. It outfalls into the Ganga in Bihar about 40 km. west of Patna after passing through the States of Madhya Pradesh and Uttar Pradesh. Its main tributary in the State of Bihar is the North Koel. The river is rainfed and during summer its discharge is negligible.

Between Patna and Maniharighat the Ganga is joined by a number of streams including the Burhi Gandak, the Bagmati, the Kamla and the Kosi flowing from the southern slopes of the Himalayas. Of these the main

tributary is the Kosi which gathers the waters of three tributaries, the Sun Kosi from the west, the Arun from the north, and the Tamur from the east, before it joins the Ganga a few km. upstream of Maniharighat. Below the confluence, it flows for about 10 km. in a narrow gorge and then debouches into the plains at Chatra. The Kosi is a very unstable and unpredictable river, and has frequently changed its course in Bihar. The only stream which joins the Ganga on the left bank after its confluence with the Kosi is the Mahananda. Thereafter, skirting the Rajmahal hills, the Ganga turns sharply southwards near the ruins of the city of Gaur and enters West Bengal.

Other important though not very large rivers of south Bihar and Chhota Nagpur are the Chandan which originates in the Deoghar hills and falls into the Ganga; the Ajoy which rises from the thickly wooded hills of Monghyr district and falls into the Bhagirathi; the South Koel and the Sankh which join the Brahmani in Orissa; and the once notorious Damodar which drains into the Bhagirathi in West Bengal after traversing 288 km. in Bihar.

Hydrological Observations

3.9 In Bihar, except for major rivers like the Kosi, the Gandak and the Damodar, very little information on gauge and discharge of the rivers in different seasons is available prior to 1950. Whatever information is available comes from the Railway Department which was maintaining the gauge discharge records at the major railway bridges in the State. It was only when the First Five Year Plan was taken up and new irrigation schemes were planned that steps were taken to establish gauge and discharge stations on the different rivers. It is unfortunate, that the gauge discharge stations have been operated on an ad hoc basis and not on the basis of a continuing policy. We found, for example, that gauge stations were operated for some time and later abandoned or withdrawn. The lack of continuity in observations has lessened the utility of the data from these stations.

The gauge and discharge records maintained in the State have been found to be inadequate. In many cases, long-term data essential for making reliable estimates of the average annual runoff and safe yields are not available. Many of the tributaries of the bigger rivers have not a single gauging station. Further, as the hill catchment areas of some rivers lie in Nepal, very little hydrological information is available for them.

Rough Estimates of Flow

3.10 The Bihar Irrigation Commission has made an assessment of the

water resources of the State. However, in most cases the water resources of the basins have been worked out on the basis of the available discharge data for a few stations set up by the department in the last 5 to 8 years.

The water resources of Bihar rivers, according to the State Irrigation Commission are as follows:

Table 3.4

Water Resources of North Bihar Rivers

(*m.cu.m.*)

River	Water Resources	
	At the point of entry from Nepal to India	In North Bihar portion only
1	2	3
Kosi	44,652 (at Chatra)	Total 17,762
Gandak	50,573 (at Valmikinagar)	
Kamla	2,041	
Mahananda	5,304	
Bagmati and Adhwara rivers	7,697	
Total	110,267	17,762

Table 3.5

Water Resources of South Bihar Rivers

(*m.cu.m.*)

River	Water potential in other States before entering Bihar	Water ptential in Bihar portion only
1	2	3
Karamnasa	1,307	2,541
Son	9,604	4,791
Punpun	—	2,072
Kiul	—	5,939
Badua	—	829
Chandan	—	728
Berua, Bhena and Koa	—	1,342
Total	10,911	18,242

Table 3.6

Water Resources of Chhota Nagpur and Santhal Parganas

(*m.cu.m.*)

River	Water potential in other States before entering Bihar	Water potential in Bihar portion only
1	2	3
Gumani	—	795
Ajoy	—	1,647
Damodar	—	6,550
Subarnarekha	1,446	6,695
South Koel	—	6,202
Sankh	784	2,189
Total	2,230	24,078

Ground Water Resources

3.11 Excluding the plateau and sub-plateau areas of Gaya, Shahabad, Bhagalpur, Monghyr, Hazaribagh, Palamau, Santhal Parganas, Ranchi and Singhbhum districts and a small portion of north-west Champaran district, large scale ground water development is feasible in most of Bihar, particularly in the northern districts.

The index map prepared by the Bihar State Irrigation Commission shows the pattern of ground water in the State, based on yield. Areas of high yield are those where the yield is ninety thousand litres per hour or more; areas of moderate yield are those where the yield is twenty thousand to ninety thousand litres per hour; and of low yield where the yield is below twenty thousand litres per hour. Table 3.7 shows the distribution according to yields.

The culturable areas in north Bihar with the exception of Champaran district north of the Don Canals, are areas where the ground water resources are high yielding. In south Bihar, the Gaya plains are also underlain by high yielding aquifers.

The low yield areas are in the south. There is a possibility of tapping artesian aquifers in the northern part of Champaran, Muzaffarpur and Darbhanga districts on the border of Nepal.

Table 3.7

Pattern of Ground Water Yield in Bihar State

(*Thousand hectares*)

Description	Area		Total
	North Bihar	South Bihar	
1	2	3	4
High yielding area	5,464	901	6,365
Moderate yield area	13	252	265
Low yield area	—	796	796
Rockey belt	142	9,837	9,979
Total	5,619	11,786	17,405

Present Stage of Development of Irrigation

3.12 There were only four pre-Independence irrigation projects viz., the Son River Project, the Tribeni Canal Project, the Dhaka Canal Project, and the Tour or Tirhut Canal Project. The idea of using the waters of the Son river for irrigation was conceived in the 1850's by Col. C. H. Dickens and was put into execution by the East India Irrigation and Canal Company. As the work proved to be beyond their capacity, it was handed back to Government in 1868. Work on the Son Canals commenced only in 1869 and was completed in 1875 at a cost of Rs. 26.82 million to benefit an area of 347,230 hectares in the districts of Patna, Gaya and Shahabad. The project comprised a weir across the Son at Dehri with a left bank and a right bank canal. After Independence, the Son Canals were remodelled and a barrage and two new high level canals were constructed. The main features of the system have been described later.

To protect a precarious tract in the Champaran district to the north of the river Gandak, the Tribeni Canal was taken up in 1897, to begin with as a relief work. It was completed in 1914 at a cost of Rs. 8.16 million and benefited 48,160 hectares. Originally conceived as a single canal, 98 km. long, taking off from the Gandak just below the boundary of India with Nepal, the system has since 1951, been enlarged.

Like the Tribeni, the Dhaka Canal from the Lalbakeya river was also taken up in 1897 as a relief work to irrigate about 6,480 hectares.

The Tour or Trihut Canal was constructed in 1876 to irrigate 1,620 hectares.

During the period between 1951 and March, 1969, the following irrigation projects have been completed.

Table 3.8

Projects completed between 1951 and March, 1969 in Bihar State

Name of project	Estimated cost (Rs. million) (latest)	Ultimate benefit (thousand hectares)
1	2	3
Sakri Lower Valley	3.38	20.24
Tribeni Canal Expansion	2.98	11.33
Drainage of chaurs and other irrigation schemes	3.76	39.94
Emergency river pumping schemes	3.90	5.26
Irrigation weirs and dams in hilly districts	3.11	15.10
Botane Irrigation	1.85	6.68
Upper Northern Irrigation Scheme	5.61	14.57
Lilajan	6.50	22.66
Durgawati	3.66	10.52
Kaurihari	5.65	11.66
Kharagpur Lake	2.40	2.63
Khawa	1.55	4.25
Lower Morhar	5.68	14.97
Adri	1.53	4.25
Jinjoi	1.48	3.04
Nagi	4.02	3.04
Mayurakshi L. B. Canal	8.11	10.12
Tribeni Canal Extension	11.20	25.13
Kamla Canal	3.09	15.38
Khajia Phase I, including Chandan Phase I	2.21 +4.20	19.00
Lower Kiul	8.77	25.00
Torlow	1.62	2.20
Chako	1.60	2.33
Panchane Phase II	4.41	12.55
Sakri Canal Phase II	3.79	5.06
Kohira Dam	5.68	10.32
Kamla Weir	7.78	**
Badua Reservoir Project	62.80	42.49

**This will assure supply of water to the existing Kamla Canal and the Kamla Irrigation Scheme.

Table 3.9 gives a list of projects costing Rs. Ten million and above and which are at present under construction.

Table 3.9

Projects Costing More Than Rs. 10 Million Under Construction

Name of project	Esitmated cost (Rs. million (latest)	Ultimate benefit (Thousand hectares)
1	2	3
Kosi	595.7	568.50
Sone Barrage (including link canals and remodelling of Sone Canals)	183.2	124.00
Gandak Project		
(a) Bihar & Nepal portion	1,190.0 in Bihar & 115.3 in Nepal	1,199.13 in Bihar & 47.37 in Napal
(b) U.P. portion	303.5	288.04
Morwa	12.6	4.90
Kanchi Weir	15.2	18.21
Bore	13.6	10.93
Western Kosi Canal System	196.9	325.28 (313.14 in Bihar & 12.14 in Nepal)
Irrigation of area between Kosi Eastern Embankment and Bhangadhar (Rajpur Canal)	68.2	160.67
Chandan	99.2	40.47
Udrasthan Irrigation	13.5	24.88
Kamla Irrigation	11.5	14.16
Son High Level Canals	88.4	101.98
Musakhand (Karamnasa)	17.9	11.73

3.13 A brief description of the important projects is given below:—

Gandak Project

The Gandak Project, begun in 1960, will ultimately irrigate 1.20 million hectares in Uttar Pradesh, Bihar and Nepal. The project comprises (*a*) a 743 m. long barrage at Valmikinagar across the Gandak situated 762 m. below the existing Tribeni head regulator; (*b*) Eastern Canal System, 250 km. in length; (*c*) Western Canal System, 193 km. in length; and (*d*) a power house in Nepal territory on the main Western Canal with a firm power capacity of 15,000 KW which will be all to the benefit of Nepal. The project is estimated to cost Rs. 1,586 million out of which the share of

Bihar is about Rs. 1,192 million. It has made substantial progress. Out of the 1,321 structures involved in the various canal systems, 971 have been completed, in addition to the barrage and head regulator. Work on the portion of Western Canal lying in Nepal, has been suspended because of a fresh proposal made by the His Majesty's Government of Nepal to expand the capacity of the canal to cover an additional 26 thousand hectares of land in the Marchwa area.

The Tirhut Main Canal was opened in June 1969 to give irrigation in the kharif season to about 18 thousand hectares. It is estimated that 28 thousand hectares would have received irrigation from this canal in the kharif season of 1970-71. The major beneficiary from the irrigation portion of the project is Bihar, which will get water to irrigate 1.15 million hectares out of the total irrigation potential of 1.20 million hectares.

The Kosi Project

The Kosi Project on which work began in 1955, is expected to cost Rs. 1,100 million and to provide irrigation through its three main canals to about one million hectares of land, and to generate 20,000 KW of power (50 per cent of which will go to Nepal), besides controlling the annual flood devastation by the turbulent river. The main barrage is sited in Nepal about 5 km. beyond Hanuman Nagar, and flood control is assisted by two flood embankments on both banks of the river, upstream and downstream of the barrage, for a total length of 270 km. The importance of the flood control in the Kosi can be gauged from the fact that out of the Rs. 1,100 million which the total project is likely to cost on completion, as much as Rs. 360 million will be the share of flood control. The flood control embankments and the special protection works for them were completed in 1959 within two years of the start of the project. The barrage itself was completed four years later, in 1963.

Out of 2,481 canal structures, as many as 2,144 have been completed. Of the three canals, the Eastern Kosi Canal will irrigate 0.57 million hectares, the Western Kosi Canal 0.32 million hectares and the Rajpur Canal 0.16 million hectares. Provision has been made for the drainage, the clearance of silt in the main canals, and the construction of silt ejectors.

The Son Project

As already mentioned, the Son Canal is the oldest irrigation works of Bihar. The current schemes for remodelling, extending and improving it involve the construction of a barrage across the river 1,407 m. in length, and of two high level canals. The remodelling of the old canal and the erection of the barrage are likely to cost about Rs. 183.2 million and the

high level canals an additional Rs. 88.4 million. On completion it will provide irrigation to 100 thousand hectares in addition to the 124 thousand hectares to be irrigated by the main Son Canal.

Chandan Dam Project

Constructed to irrigate 40 thousand hectares of land, the Chandan Project comprises an earthen dam 2,019 m. in length, and 40 m. in height on the river in the Bhagalpur district, and a high-level canal with distributaries. The total cost is likely to be of the order of Rs. 100 million.

Badua Reservoir Project

The Badua Reservoir Project includes an earthen dam across the river Badua, 42 m. high from the river bed at the deepest section, and 457 m. long, and two canals. The right bank main canal has a discharge capacity of 15.57 cumecs and the left bank main canal of 12.74 cumecs. The project has been constructed at a cost of Rs. 66 million and on full development will irrigate 42.5 thousand hectares.

Wells & Tubewells

Ground water exploited in the State is through tubewells and open wells. Table 3.10 shows details of the position in March, 1969.

Table 3.10

Number of State Tubewells, Private Tubewells, and Open Borings Drilled till March, 1969

District	Private tubewells	State tubewells	Open borings
Patna	1,204	292	6,387
Gaya	187	115	8,018
Shahabad	1,994	390	5,728
Saran	738	154	6,061
Champaran	500	128	193
Muzaffarpur	1,150	117	983
Darbhanga	887	125	8
Monghyr	978	105	1,571
Bhagalpur	282	42	1,637
Purnea	1,092	—	Not known
Saharsa	742	—	Not known
Total	9,754	1,468	30,586

While the shallow aquifers are generally meant to be tapped by open bore wells and by private tubewells, State tubewells go down to the deeper aquifers and have discharges of the order of 156 thousand litres per hour. The State tubewells are economical, both in construction and in operation but administrative difficulties in maintaining and running them have been responsible for their lack of popularity with the farmers, who feel that the State tubewells are erratic in operation and cannot be relied upon.

Source-wise Irrigation

3.14 The areas irrigated from different sources in 1968-69 are as follows:

Table 3.11

Area Irrigated—Source-wise (1968-69)

(Thousand hectares)

Source	Area irrigated
1	2
Canals	
(a) Government	787
(b) Private	5
Tanks	187
Tubewells	260
Wells	199
Other sources (pynes, ahars, rivers etc.)	736
Total	2,174

3.15 The salient features of schemes which irrigate more than 4 thousand hectares are given in Appendix 3.1.

Ayacut Development

3.16 The Government of Bihar has formulated programmes for the integrated development of the Kosi ayacut through the Development Commissioner of the Kosi area. These include the construction of water courses, the levelling of culturable land, the reclamation of waste land, the consolidation of holdings and a campaign to encourage farmers to build field channels. In addition, the programme of agricultural extension covers the establishment of co-operative credit societies for the supply of seeds and

agricultural implements, the demonstration of improved agricultural practices and the use of irrigation water.

The Intensive Area Development Programme has been introduced in a number of blocks in the districts of Purnea and Saharsa and will be gradually extended to other blocks.

The main problem in Bihar, as in other States, is that of leading irrigation water to points as close as possible to the fields. In 1965 the State Government decided to bear the cost of water courses up to 0.057 cumec (2 cusecs) and in some cases even up to 0.0283 cumec (1 cusec) capacity. At present the farmers are required to build field channels within the forty hectares 'chak' or block in the command of the smallest water courses constructed by the project.

The entire command of the Kosi Canals has been divided into zones for the study of sub-soil water, the behaviour of abandoned channels of the Kosi, rainfall, the effect of irrigation on vegetation and crop yields, the status and condition of main and trunk drains, the problem of underground drainage, and the development of alkalinity, salinity etc.

The Agriculture Refinance Corporation has sanctioned an ambitious scheme to sink 8,050 private tubewells of 10-15 cm. capacity at a cost of Rs. 67 million. The scheme will operate under the supervision of the Kosi Area Development Commissioner and will be implemented by the Land Mortgage Bank.

3.17 An effort is being made to irrigate more culturable land within the command of the Kosi through land levelling and land reclamation. This involves the reclamation of land in the abandoned beds of the Kosi and the removal of scrub-jungle in many areas. On about 25 per cent of the land which requires levelling, tractors and scrapers will have to be deployed. The State Government proposes to set up a unit of 100 tractors for the purpose of reclamation and levelling. Nine heavy duty tractors have also been made available for this work by the State Tractor Organisation. However, progress appears to be slow, largely because of the high cost of reclamation and the inability of farmers to bear it. The question of cost needs to be looked into. In particular, the smaller cultivator would need financial and other assistance. We are given to understand that the State Government is arranging demonstrations to bring home to farmers the benefits of land levelling.

The State Land Mortgage Bank has formulated a scheme to finance the purchase of 600 tractors to be made available to farmers for levelling their own land and the land of other farmers at rates prescribed by the Government. In addition a fleet of 600 tractors will be provided to the State Tractor Organisation for land levelling and land reclamation in the ayacut. The Land Development Bank is also advancing long-term loans for the purchase

of tractors, and the Agro-Industries Corporation is supplying tractors, sprayers and threshers on a hire-purchase basis.

3.18 The State Government has set up a fully equipped soil testing laboratory at a cost of Rs. 0.21 million at Purnea to serve Purnea and Saharsa districts.

3.19 The State Government proposes to set up a seed farm covering 4 thousand hectares at a cost of Rs. 20 million to produce paddy, jute, potato and wheat seed. In addition, a smaller 400 hectares farm at a cost of Rs. 1.8 million will be set up to provide seed for hybrid maize and other crops. Together, these farms are expected to supply high-yielding varieties of seed to 25 per cent of the area in kharif and 50 per cent of the area in rabi.

3.20 Provision has also been made for the controlled breeding of 400,000 cows and 100,000 she-buffaloes. A seed production farm of 400 hectares will provide fodder seed. Poultry farming is also to be encouraged by giving loans and advances to farmers in poultry pockets, which will be set up in various parts of the State.

3.21 Based on the experience of the Kosi Area Development Scheme, the Gandak Area Development Scheme was conceived in 1968 and the Area Development Programme was started soon after the canal was opened in 1968. The main features of this programme, in brief, are given below:

Table 3.12

Main Features of the Gandak Area Development Scheme

Scheme	Units	Cost (Rs. million)
1	2	3
Sinking of Tubewells	7,200	67.47
Installation of River Pumping Sets	2,250	13.85
Supply of Tractors	4,000	110.00
Supply of Agricultural Implements	4,000	8.05
Custom Service Units	5	6.08
Development of Orchards	12,000 (0.2 hectare each)	21.60
Fruit Processing & Dehydration	6.1 tonnes	10.09
Fishery Development		30.49
Development of Roads	39	62.22
Improved Storage	18,300 (Godowns etc)	17.02
Improved Mode of Transport (Tyre fitted bullock-carts)	20,000	40.00
	Total	386.37

The Commission has noted with great concern that because attempts through the panchayats and lambardars to induce cultivators to construct channels have failed, the utilisation of water both in the Kosi and in the Gandak canal system actually dropped in 1969-70 compared with the previous years. Against the utilisation target of 260,000 hectares in the Kosi and 55,000 hectares in the Gandak, the actual utilisation in 1969-70 was 121,000 hectares and 18,000 hectares respectively.

3.22 Because of the slow utilisation of water in the canal systems of the Kosi and the Gandak, the need for an accelerated programme of extension and training has become urgent. Recognising this urgency the State Government has recently set up four hundred farm service units to ensure the timely supply of credits and inputs and to guide farmers in processing and marketing their produce.

Drought Affected Areas

3.23 In the State there are two pockets which are particularly vulnerable to drought—one towards the east, comprising parts of Bhagalpur, Santhal Parganas and Purnea, and another in the west comprising parts of Patna, Gaya, Saran and Shahabad. Because of the high evapo-transpiration needs and the comparatively inadequate rainfall in some areas, conditions very close to semi-aridity obtain in parts of Patna, Gaya, Monghyr and Hazaribagh districts and are conducive to drought.

Bihar has experienced several droughts and famines during the last 200 years. The more calamitous of these were in 1770, 1866-67, 1874, 1896-97 and 1908. In the recent droughts of 1966-67, Bihar was one of the worst affected States. This drought climaxed a series of years with deficient rainfall, and large numbers of wells dried up and irrigation from canals proved inadequate to save standing crops. The districts most affected were Gaya, Hazaribagh and Palamau.

Following the drought and famine in 1967, the State Government undertook an extensive programme of drilling tubewells for irrigation in the alluvial tracts where ground water resources are adequate. It has also taken up a scheme under which it will subsidise farmers who wish to have high-capacity tubewells on their farms. The Government will also sink wells for farmers who take the subsidy.

Future Development of Irrigation

3.24 Irrigation in Bihar has hitherto been almost exclusively by means of weirs, but diversion schemes of this nature fail to function during periods of drought, due to their dependence on run-of-the-river supplies. There

are good sites for the location of storage reservoirs in most of the river basins, and investigations are now being carried out to select the most favourable sites for dams. The State Government's plans comprise (*i*) the construction of a network of small storage reservoirs on the tributaries of the main rivers to irrigate smaller commands. These will also be helpful in controlling floods; (*ii*) the construction of a large number of new tanks and the deepening of existing tanks. It is also proposed to renovate 4 thousand private tanks and 2 thousand Government tanks; (*iii*) the construction of large-diameter (8 to 10 m.) wells in the Don river lands, each of which will irrigate one hectare; (*iv*) pumping the sub-surface flows of river-beds through 3 m. long horizontal strainers; (*v*) the construction of storage dams with pick-up weirs for irrigating the valley; (*vi*) the construction of medium and minor irrigation works.

In the Santhal Parganas, the Gumani and the Ajoy rivers have not been tapped. On both these rivers, good storage reservoir sites have been located. Large reservoirs have been proposed on the South Koel and the Sankh rivers for hydro-power generation. We recommend that the possibility of irrigation and the development of fisheries from these reservoirs should be investigated.

3.25 The State Irrigation Commission has estimated that with the proper utilisation of surface water resources, Bihar has a potential irrigation capacity of 5.8 million hectares, distributed as follows:

North Bihar	3.1 million hectares
South Bihar	1.7 ,, ,,
Chhota Nagpur and Santhal Parganas	1.0 ,, ,,
Total	5.8 million hectares

There are also immense possibilities for the exploitation of the large reserves of ground water, which underlie about 50,400 sq.km. of its alluvium-covered area. Only 13 per cent of this potential has so far been explored by tubewells. We understand that credit facilities are available and if the pace of rural electrification to energise tubewells could be accelerated, there is every reason to expect success in the exploitation of ground water. The key to rapid progress lies in the expansion of rural electrification in which field Bihar is trailing behind many other States.

The total number of pumps energized since 1969, is only 51,625. Because of the importance of rural electrification in the programme for extending irrigation in the Fourth Plan, a provision of Rs. 500 million has been made. Of this amount, Rs. 100 million would be provided by the Life Insurance

Corporation, Rs. 100 million by the Agricultural Refinance Corporation, and Rs. 50 million will come in from consumers who will pay the cost of connections. The Fourth Plan target for energizing pumps is 125,000, and by the end of the Fourth Plan, the total number of pumps electrified is expected to be 176,225.

Taking into account the irrigation potential of all types of future irrigation works, the State can irrigate an additional area of one million hectares which will bring the total area irrigated to about 7.6 million hectares. This works out to about 70 per cent of the gross cropped area.

Table 3.13

Ultimate Irrigation in Bihar State

(*Million hectares*)

Item	Major & medium projects	Minor irrigation works	Total
1	2	3	4
Area irrigated in 1969	0.9	1.8	2.7
Additional area that will be brought under irrigation on completion of projects under execution	3.2	0.8	4.0
New Projects	0.4	0.5	0.9
Total	4.5	3.1	7.6

Floods

3.26 North Bihar frequently suffers from the ravages of floods which cause widespread devastation and frequent loss of human and cattle life.

The three zones most affected by floods are; the Gandak valley between the Burhi Gandak and the Ghaghara, the area between the Burhi Gandak and the Kosi and the area between the Bhutahi Balan and the Mahananda, i.e. the Kosi valley.

The Kosi valley is the area most subject to recurrent floods of the greatest severity. Almost all the rivers of the area between the Burhi Gandak and the Kosi, and those flowing in the Kosi valley, meet the river Ghugri which flows into the Ganga at Kursela. Though south Bihar is less often and less severely affected by floods, several of its many rivers like the Badua, the Chandan, the Kiul, the Pun Pun and the Son present problems of flood control.

Prior to 1954, the control of floods was left to private initiative and enterprise, and a number of large embankments were constructed by zamindars in the Gandak basin to protect the cultivated areas. The details of some of these works are given in Table 3.14.

Table 3.14

Flood Control Works Constructed Before 1954

Name of scheme	River basin	District	Length of embankments (km)	Total benefited area (thousand hectares)
1	2	3	4	5
Saran Embankments	Gandak	Saran	191	618
Champaran Embankments	Gandak	Champaran	100	74
Tirhut Embankments	Gandak	Muzaffarpur	87	324

During the first decade of planning, between 1951 and 1961 when Rs. 224.4 million were spent on flood control, the most important schemes involved protection against the floods in the Kosi-Embankments constructed for a distance of 241 km on either side of this river protected an area of 214 thousand hectares in Bihar and 51 thousand hectares in Nepal. Similar embankments were constructed on the Burhi Gandak, the Bagmati, the Adhwara and the Kamla Balan to protect about 934 thousand hectares. Thus, in addition to a million hectares protected prior to 1951, 1.16 million hectares were given protection against flood through schemes executed between 1951 and March 1961. During the years 1961 to 1966, the protected area increased further by 147 thousand hectares at a cost of Rs. 136.5 million. Between 1966-68 an additional sum of Rs. 44.7 million was spent on flood control.

In the Fourth Plan the main emphasis will again be on the building of defences against the Kosi floods. For this purpose Rs. 80 million have been allocated, partly for extending protection to new areas, and partly to strengthen existing embankments.

The State Government proposes to charge individual repairs costing Rs. 1 million or more to capital account and all expenditure less than this figure to revenue account. The expenditure chargeable to capital account in the Fourth Plan has been estimated to be Rs. 6 million per annum or Rs. 30 million for the Plan.

To secure additional protection against the Kosi floods and to take the first brunt of these floods the State Government plans to raise a second line of embankments between the present embankments and the Kosi river. Apart from making more riverine land available for cultivation and increasing the protection to irrigated areas on the banks of the river, this scheme, by further constricting the waters of the Kosi, will lead to a deepening of its course and to increasing its hydraulic efficiency and capacity to transport sand. The tentative cost of the scheme, which is still under investigation, is about Rs. 150 million.

Under the Kosi Agreement between the Government of Nepal and the Bihar Government, the latter is responsible for protecting whatever areas in Nepal suffer from erosion by the river. In the discharge of this responsibility the State Government proposes to construct protection works along the western embankment near Jabalpur village where the river is eroding its banks.

A scheme has been worked out in consultation with the Central Water and Power Research Station at Poona to project the river and to construct permeable spurs in this area as anti-erosion measures at a total cost of Rs. 33.75 million.

Besides the above schemes, the State Government is anxious to put up a second barrage at Dagmara, about 26 km. downstream of the existing barrage at Bhimnagar, to control the river gradient and arrest erosion of embankments. The proposal is reported to be under consideration by the Union Government.

The Fourth Plan also provides Rs. 17 million for a number of schemes which have spilled over from the previous Plans such as those of Sikrahna, Bagmati, Kamla Balan and Mokamehtal.

Work remaining to be completed on the Kamla Balan and Bagmati at the end of the Fourth Plan period will spill over into the Fifth Plan. Among the schemes projected for the Fifth Plan is the Ulai Reservoir Project on the Kiul in south Bihar, which will be an important factor in controlling floods in the area.

Waterlogging

3.27 The eastern part of Purnea district, the areas to the south of the Kosi Main Canal and within 8 km. of it, and the areas to the south of the Arora Branch Canal, are all subject to waterlogging through a rise in the water table when the canals are flowing. Waterlogging also exists in low-lying areas in the districts through which the canals pass. This problem, as also the problem of drainage, were brought to our notice during our visit to the Gandak command and we have made recommendations relating to it at the end of this chapter.

Water Rates

3.28 Water rates on most of the irrigation projects have been recently revised by the Bihar Government in February, 1970. The notified water rates are as follows:

Class of lease	Water supplied		Rate per acre Rs.	To be paid on or before
	From	To		
1	2	3	4	5
1. *Kharif*				
(a) Long term	25th June	25th March	28	31st Jan.
(b) Seasonal	25th June	25th Oct.	24	31st Jan.
(c) Single watering	25th June	25th Oct.	14	On demand
2. *Rabi*				
(a) Seasonal	26th Oct.	25th March	14	31st May
(b) Single watering	26th Oct.	25th March	12	31st May
3. *Hot Weather*				
(a) Seasonal sugarcane	25th Feb. 26th March	25th May 24th June	42	30th Sept.
(b) Other than seasonal sugarcane	1st March 25th Feb.	24th June 25th May	28	30th Sept.
(c) Seasonal jute	1st March	24th June	12	30th Sept.
(d) Single watering	26th March 25th Feb.	24th June 25th May	15	30th Sept.
4. *After Hot Weather* Single watering for sugarcane	—	—	14	On demand

The following water rates were fixed by the Bihar Government for lift irrigation works in March, 1968:

Class of lease	Period	Nature of crops	No. of waterings without limitation on volumetric basis of supply of water	Rate per acre Rs.
1	2	3	4	5
Kharif				
(1) Kharif season lease	25th June to 25th Oct.	Paddy	Three waterings	16
(2) Other than kharif season lease (single watering)	25th June to 25th Oct.	Paddy and other food crops like marua, kodo, etc.	Single watering	6

Rabi				
(3) Rabi season lease	26th Oct. to 25th March	Wheat, barley gram, peas and other food crops	Two waterings	12
(4) Other than rabi season lease (single watering)	26th Oct. to 25th March	(a) Wheat, barley, gram, peas and other food crops	Single watering	7
		(b) Chillies and to-bacco	Single watering	10
(5) Rabi season	26th Oct. to 25th March	(a) Early potato	Four waterings	20
		(b) Double potato	Nine waterings	34
		(c) Late potato	Six waterings	20
Hot weather				
(6) Hot weather season lease	26th March to 24th June	(a) Crops other than sugarcane	Two waterings	12
		(b) Sugarcane	Three waterings	28
		(c) Summer paddy & maize.	Three waterings	16
		(d) Summer paddy & maize	If more than three waterings are demanded there would be additional charge	6
(7) Other than hot weather season lease (single watering)	26th March to 24th June	(a) Crops other than sugarcane	Single watering	8
		(b) Sugarcane	Single watering	12

In our opinion the irrigation rates are very low and need to be revised upwards. Unless reasonable irrigation rates are levied, it will not be possible for the State to muster adequate resources for its development plans.

We would draw the attention of the State Government to Chapter X of Volume I of this report, where we have dealt in some detail with the question of water rates, and the considerations which have to be kept in mind while fixing them.

Betterment Levy

3.29 In 1959, the State Government enacted the Bihar Irrigation and Flood Protection (Betterment Contribution) Act, 1959. The rates of contributions are as follows:

	Rate of levy
(a) Irrigation work, not being a storage dam or reservoir where the flow of water is not perennial	Rs. 75 per acre
(b) Irrigation work, not being a storage dam or reservoir where the flow of water is perennial	Rs. 105 per acre
(c) Storage dam or reservoir	Rs. 120 per acre

The betterment contribution may be paid in fifteen equal annual instalments. Rebates at the rate of 20 per cent and 15 per cent respectively have been provided if the entire amount is paid within one year and two years after service of notice. However, we noticed with regret that betterment levies have not been recovered even from those whose holdings have been protected from floods as a result of the construction of embankments or marginal bunds. We were given to understand that no portion of the Rs. 20 million which is being spent every year on the maintenance of flood control works, is being collected from those who benefit from these works. This is anomalous and calls for the attention of the State Government.

Tours, Observations and Impressions

3.30 We toured Bihar State from the 15th to the 20th November, 1971, visiting Muzaffarpur, Motihari, Darbhanga, Saharsa, Patna and Shahabad districts. The Chief Engineer, the Director of Agriculture and other officers accompanied us during the tour. We saw portions of the Kosi and Gandak Project areas, the weir across the Kamla, the recently constructed barrage across the Son and portions of the Son ayacut. We also visited and held discussions at the Agricultural University campus at Dholi, and the Pusa Sugarcane Research Institute. At Patna we had meetings with the Chief Minister and with the Officers concerned. Our observations relating to this tour are given below.

Kosi Project

3.31 Though the Eastern Kosi Canal was opened for irrigation as far back as 1964, and ayacut development is being carried out under the guidance of a whole-time Area Development Commissioner, no appreciable headway has been made in constructing field and drainage channels, in the consolidation of holdings, and cultivation of high-yielding varieties. It appears that the farmers are reluctant to excavate field channels, with the result that the development of irrigation has not progressed satisfactorily.

Land levelling has also not made much progress. Out of the 0.57 million

hectares of the C.C.A. nearly 25 per cent requires levelling. Even though the Agricultural Refinance Corporation has sanctioned a scheme for the purpose, and necessary staff and machinery have been provided for both Purnea and Saharsa, so far only about 400 hectares in both districts have been levelled during the last two years. Due to lack of adequate demand, the tractors are reported to have worked, on an average, for only 100 days in a year. The main reasons for the lack of response are said to be the inability of the department to provide the promised irrigation, and the tendency on the part of the farmers to wait hopefully for a Government subsidy. Necessary action is called for to provide the water according to schedule, and to dispel the false hopes of the farmers that they will be given a subsidy.

After 7 years of the opening of the canal, the irrigation in kharif 1971 was 0.12 million hectares against 0.32 million hectares envisaged for the year in the project report. The project has been designed for the low intensity of 75 per cent during kharif and 25 per cent during rabi. The minimum discharge in the river during the rabi season is of the order of 283 cumecs. This should enable an area of 0.32 to 0.36 million hectares to be irrigated during rabi also, whereas the present rabi irrigation is insignificant. There is, therefore, gross under-utilisation of the irrigation potential of this system, both in kharif and rabi. Urgent steps are necessary to utilise the full potential.

The ground water-table in the command area is high. With the introduction of copious and extensive irrigation in this area, the water table is bound to rise unless steps are taken to control it. A detailed study should be made of the data so far collected, to ascertain the behaviour of the ground water-table, and to enable measures to be taken to prevent damage. Though there is ample ground water no scheme has so far been prepared to exploit it and thereby to increase the intensity of rabi irrigation. By supplementing surface supplies with ground water, rabi intensities could be considerably increased. Such a step would, in addition, provide a safeguard against a rise of the water-table.

What attracted our notice most during our tour was the presence of huge quantities of sediment in the canal system. Heavy deposits of sediment in a canal can be even more disturbing than those in a reservoir. We noticed that the sediment, in the shape of fine sand, was entering the canal in large quantities, silting to a depth of about 2.7 m. at the head and 0.6 m. near the tail. Silt clearance is necessary to enable the canal to function properly, and we were told that between 1967 and 1971 the quantity of silt removed from the main canal amounted to 2.8 m.cu.m. Silt clearance has cost the State Government about Rs. 10 million. The heavy silting up of the canal is a serious problem which deserves the immediate attention of the State Government. We have dealt with this problem in Volume I of our report and have suggested some improvements which could be effected after due

investigation. We have also suggested that irrigation be confined to the kharif season, and should begin only if required during the critical stages of crop growth, so that sedimentation is reduced to the minimum.

Western Kosi Canal

3.32 We were informed that there is a proposal to take a canal on the west bank above the barrage, to irrigate areas in Nepal and Bihar. As we have indicated, the working of the Eastern Canal has not been quite satisfactory, both from the point of view of the area irrigated and the problem of heavy sedimentation. We feel, therefore, that the proposal to construct a canal on the west bank should be thoroughly examined before it is accepted. The possibilities of using ground water to irrigate the areas included in the command of the west bank canal should also be carefully investigated.

Gandak Project

This project has now been under construction for the last 10 years, and with the present pattern of financing its completion is likely to be prolonged indefinitely. The State Government should take steps for the early completion of this project.

No appreciable headway has been made to develop the ayacut, though a separate Area Development Commissioner has been posted for this work. The development of irrigation has been very slow during the last three years due to favourable rains, as a result of which the cultivators are reported to have been reluctant to draw water for kharif irrigation. There is need to take effective steps for speeding up the utilisation of the potential created.

3.33 Drainage appears to be a very serious problem in the area, but so far no surface drainage has been planned. There are a large number of depressions in the Gandak command, locally known as Chaurs, which remain full of water practically all the year round. The financial provision for draining these large submerged areas, seems to be only nominal. With the introduction of surface irrigation, the present difficulties are bound to be aggravated unless suitable drainage channels are excavated as early as possible. The State Government should also consider the possibility of installing heavy-duty tubewells, not only to reclaim these areas, but to provide irrigation for additional areas in the rabi season. At present, irrigation from State tubewells in this command is limited to high patches which cannot receive water from the canal system.

It is also necessary to carry out studies on the behaviour of the ground water-table, so that suitable action can be taken to avoid difficulties arising

from an abnormal rise of the water-table after canal irrigation becomes fairly widespread.

Research Station

3.34 There is no agricultural research station to cater to the needs of the command area, in either the Kosi or the Gandak Project. It is necessary to start an agricultural research station as early as possible in each of these project commands to evolve suitable short-duration high-yielding varieties, and also to determine cropping patterns for achieving high intensities.

Kamla Weir

3.35 The silt problem in the Kamla river and the canal is similar to that obtaining in the Kosi system. The weir has under-shot gates on the right side and drop-shutters on the rest of the weir. These shutters, when raised, trap silt and inject it into the canal. The State Government may consider replacing the weir with a barrage.

Son Canal System

3.36 This canal system, now almost a century old, has recently been expanded by the construction of a barrage, about 8 km. upstream of the old anicut across the river, built in 1874. The canal system has a gross command area of 0.69 million hectares and a C.C.A. of 0.49 million hectares. The area irrigated is shown below:—

Crop	Area Irrigated
Kharif paddy	0.30 million hectares
Wheat	0.24 million hectares
Summer crops	0.04 million hectares (24,281 hectares paddy)
Total :	0.58 million hectares

The intensity of the system works out to 120 per cent. It was reported to the Commission that out of 0.30 million hectares of kharif paddy, only about 15 per cent is under high-yielding varieties, and that the main reason for the low coverage as we were given to understand, is the high incidence of pests and disease. The State Government may take suitable steps for the control of pests and disease and encourage a higher coverage with high-yielding varieties.

It may also be possible to increase the area under wheat by supplemental irrigation from ground water resources, which are abundant in this region. Such ground water support to this diversion canal would help to get over the shortage of water for wheat and summer paddy.

Satta System

3.37 Under the Satta system, the farmer has to apply for irrigation water either annually or for a period of years. Those who wish to get water on an annual contract, naturally wait for the monsoon rains before applying for water from the canal. If the rains are adequate, as was the case during the last two years, there is little demand for canal water and the total area irrigated from the canal diminishes considerably.

During the course of our discussions with the State Officers, we were informed that the State Government proposes to do away with the Satta system of irrigation, and to introduce a system under which those farmers who are given assured water supplies, will have to pay irrigation charges, irrespective of whether they actually irrigatie their fields or not. We consider that such action is over-due, and that unless the Satta system is done away with, the irrigation intensity will continue to be low.

Administration

3.38 The major and medium projects in the State are, at present, looked after by different organisations, namely, the River Valley Department, and the Irrigation Department. It would be desirable to bring all the projects under one department for ensuring coordination and economy.

CHAPTER IV

GUJARAT

The Gujarat State was formed on the 1st May, 1960, as a result of the bifurcation of the former Bombay State. It is situated on the west coast of India between 20.1 and 24.7 degrees north latitude and 68.4 and 74.4 degrees east longitude. The boundaries of the State are the Arabian Sea on the west, the deserts of Pakistan and Rajasthan on the north, Rajasthan on the north-east, Madhya Pradesh on the east and Maharashtra on the south and south-east.

The State as it exists today comprises four regions which were separate political entities before Independence. These were, (*i*) the areas of the Gujarat region formerly under British rule; (*ii*) the former Princely States in the Gujarat region; (*iii*) Saurashtra and (*iv*) Kutch. The territory of Saurashtra comprised over 200 small Princely States and Principalities before Independence. Thereafter it became a Part 'B' State and remained so till the 1st November, 1956, when it was merged in the bigger State of Bombay. Kutch was also a Princely State before Independence, and a Part 'C' State thereafter, till its merger with Bombay.

The State has an area of 195,984 sq.km. which is 6 per cent of the area of the Indian Union. Its population according to the 1971 Census, was 26.7 millions, inhabiting 217 towns and 19,017 villages. This population forms 4.9 per cent of the population of the Indian Union. The density of population is 136 per sq. km. as compared to the average of 182 per sq. km. for the Indian Union. There is a wide variation in the density, ranging from almost nil in some parts of the Rann of Kutch to 340 per sq. km. in the densely populated Kaira district.

Agriculture is the mainstay of the people and provides employment to 83 per cent of the working population. The corresponding percentage for the country as a whole is 81. The average size of holdings in Gujarat varies from area to area but it is generally smaller in irrigated tracts. According to available information, the size of holdings in the irrigated areas of Kaira is in the range of 0.46 to 0.66 hectare; in Bulsar 0.57 to 1.04 hectares; in Broach 0.96 to 1.05 hectares and in Surat 0.90 to 1.44 hectares. Important crops raised by the farmers in the State are cotton, groundnut, tobacco,

bajra, jowar and wheat. Cash crops have an important place in the agricultural economy of the State.

The important rivers of Gujarat are the Narmada, the Tapi, the Mahi, the Sabarmati, the Saraswati and the Banas in the Gujarat region; and the Bhadar and the Shetrunji in the Saurashtra region. The first four rivers are inter-State rivers. Besides, there are a number of smaller rivers particularly in the Saurashtra and Kutch regions. Except the Tapi and the Narmada all the rivers in the State are non-perennial.

Physiography

4.2 The Gujarat State can be divided into the following three geographical units:

(i) The Gujarat main land
(ii) Peninsular Gujarat, and
(iii) Kutch.

The Gujarat mainland comprises extensive alluvial plains flanked by hilly terrain in the east. The plains, which are well known for the richness of their soils, have been mainly formed of alluvium laid down by the Sabarmati, the Mahi, Tapi and Narmada rivers. The terrain slopes gently towards the west and south-west and is traversed by numerous small streams. When they are in spate, the rivers flowing into the Arabian Sea and those flowing into the Gulf of Cambay sometimes join up, flooding vast tracts of country. The hills in the north and north-east constitute the Aravalli ranges which merge into the Vindhyas to the north of the Narmada river, while further south, the eastern fringes of the plains are flanked by the Satpuras and Sahyadris. Some of the areas along the northern border with Rajasthan are covered by old sand dunes.

The rivers of the mainland originate in the eastern highlands and, after flowing west and south-west, empty either into the Arabian Sea, or into the Gulf of Cambay or disappear in the sands of the Rann of Kutch. The Mahi, Narmada and Tapi rivers rise in the hilly regions of Madhya Pradesh and drain into the Gulf of Cambay. The Banas and Saraswati rise in the Aravalli Hills, and after flowing through the northern part of the plains finally disappear in the Little Rann.

Saurashtra, or peninsular Gujarat has a characteristic topography; the central part is elevated and the terrain slopes very gently towards the coastal plains and the plains of Gujarat. Girnar is the most prominent hill range, the highest peak of which is 1,117 metres (3,664 ft.) above m.s.l. Most of the rivers such as the Shetrunji, the Bhadar, the Machhu, the Bhogavo, etc. rise from this central table land and run radially, into the Gulf of Kutch, the Arabian Sea or the Gulf of Cambay.

Kutch is an isolated, detached area flanked by the Great Rann in the

north and the Little Rann in the east and south-east; the Gulf of Kutch lies to the south, and the Arabian Sea to the west of it. The Kutch land mass is crescent shaped and made up of three east-west hill ranges with plains in the south. The centre of Kutch is a tableland, the drainage being largely to the north or to the south; vast areas in this region are affected by salinity and have become unsuitable for cultivation. The region is very sparsely populated and is the most backward in the whole State.

Soils, Climate and Rainfall

4.3 The soils of Gujarat can be broadly classified into five groups: (*i*) shallow residual soil; (*ii*) medium black soils; (*iii*) deep black soils; (*iv*) sandy loam (gorat or goradu); and (*v*) coastal alluvium. On the basis of soil characteristics, the State may be divided into four distinct regions, viz. (*i*) Southern Gujarat, (*ii*) Central Gujarat, (*iii*) Northern Gujarat and (*iv*) the Saurashtra-Kutch Region.

The Southern Gujarat region comprising the districts of Baroda, Broach, Surat, Bulsar and Dangs, has deep black soils. These soils are rich and fertile and are suitable for cotton, jowar, rice, wheat and garden crops. The district of Dangs on the south-eastern fringe forms a region by itself and is covered with dense forests, rich in teak.

The Central Gujarat region which extends over Kaira, Ahmadabad and parts of Baroda and Mehsana, has sandy loam soils locally known as 'goradu'. This is one of the most fertile areas of the State. The Panchmahals and the south-eastern parts of Sabarkantha have, however, medium black soil.

The Northern Gujarat region consisting of the three northern districts of Mehsana (except its southern part), Sabarkantha (except its south-eastern part) and Banaskantha, form the poorest agricultural region of the State. The western parts of Mehsana and Banaskantha and the northern part of Saurashtra have coarse shallow soils derived from granites. The rest of the region forms part of the main shelf of firm alluvium.

The Saurashtra and Kutch peninsula, which forms the western half of the State is topographically a distinct area. Its soils are formed from the weathering of sheets of Deccan lava. There is a good deal of alluvial sandy soil with patches of medium black soil in Bhuj and in a part of the Anjar taluks, whereas a large portion of this district, known as the Rann of Kutch, is covered with desert sandy (saline) soils. In Saurashtra, the northern portion of the Jamnagar, Rajkot and Surendranagar districts have alluvial sandy soils derived from stones and conglomerates. The rest of the area has medium black soils of basaltic origin. A stretch of alluvial soil runs along the sea coast of Southern Gujarat and Saurashtra up to the

mouth of the Gulf of Kutch. At many places these soils are impregnated with salts.

4.4 The climate of Gujarat varies from region to region. On the western coast it is moist; in the eastern parts it is comparatively dry, and in the northern parts it is dry or arid. On the Saurashtra coast the climate is temperate, whereas in Kutch extremes of temperature are not uncommon. The summer is generally very hot in most parts of the State, though the winter is mild, except in the north where it is severe for a short period.

The annual normals of temperature and relative humidity for two stations viz. Ahmadabad and Surat are indicated below.

Table 4.1

Temperature and Humidity Normals

Station	Annual normal of temperatures in °C		Annual normal of relative humidity %
	Maximum	Minimum	
Ahmadabad	34.6	20.2	64.0
Surat	33.1	21.3	68.0

Both temperature and humidity are high from April to June; they are at their lowest during November to January.

Table 4.2 gives the mean (daily) evaporation for the stations mentioned above.

4.5 The average rainfall varies from 33 to 152 cm. most of which is received from the south-west monsoon. On the basis of the average annual rainfall, the nature of the rainy season and scarcity conditions, the regional features of the State can be summarised as follows:

(a) South Gujarat (Surat, Bulsar, Dangs, Panchmahals, Baroda, Broach and Sabarkantha): The rainfall varies between 76 and 152 c.m. except in some parts of Dangs lying on the borders of Thana district of Maharashtra where rainfall is around 190 cm.

(b) North Gujarat (Ahmadabad, Kaira, Gandhinagar, Banaskantha and Mehsana): The rainfall varies between 51 and 102 cm.

(c) Saurashtra: The south central high lands of the peninsula and

Table 4.2

Mean (Daily) Evaporation Data

Month	Mean (daily) evaporation (in mm)	
	Ahmadabad	Surat
January	5.2	5.6
February	6.8	7.1
March	9.1	8.5
April	11.5	10.2
May	13.0	11.0
June	10.4	11.1
July	6.2	6.4
August	4.5	5.5
September	5.5	5.6
October	6.5	6.3
November	6.0	5.3
December	5.2	5.0
Annual	7.7	7.5

Cambay gulf regions generally have rainfall of 63 cm. and over. The other parts, comprising areas of Jamnagar and Junagadh coastal regions receive generally less than 63 cm. of rainfall; and

(d) Kutch: The rainfall is very low—about 25 cm. The area is known for its semi-desert conditions.

The rainfall in the State is confined to only about 4 months in the year, i.e., from June to September and is very little during the remaining months. The crop prospects, however, depend more upon the timeliness and on the pattern of distribution of this rainfall than upon its quantum. The characteristic features of the rainfall in Gujarat are variability and unreliability. Neither the onset nor the withdrawal of the monsoon conforms to any consistent or predictable pattern. Although the monsoon normally sets in by the third week of June, sometimes it may not do so till the second week of July; in some years it may also suddenly withdraw early in September.

Under dry farming conditions, the vagaries of the monsoon seriously affect agriculture and very often, delayed sowings result in poor yields. Crops like paddy, if sown late, ripen late in the autumn and preclude the possibility of wheat and some other rabi crops being sown. On the other hand when the monsoon withdraws suddenly early in September, the unirrigated paddy crop generally fails.

Based on the coefficient of the variability of rainfall, the districts in Gujarat have been divided into four regions. Districts with a coefficient of

variability of less than 30 per cent are considered satisfactory; those with coefficients between 30% and 40% slightly low or low; those between 40 and 60% very low and those above 60 per cent exceptionally low. Table 4.3 gives the details of the rainfall regions:

Table 4.3

Rainfall Regions

Rainfall regions according to degree of reliability	Districts comprising the region	Percentage area in the region
(1) Exceptionally low reliability region (coefficient of variation —CV—above 60 per cent)	Kutch, parts of Jamnagar and Junagarh	16.5
(2) Very low reliability region (CV 40 to 60 per cent)	Banaskantha, Mehsana, Sabarkantha, parts of Jamnagar, Junagadh, Kutch, Ahmadabad, Surendranagar, Rajkot and Bhavnagar	44.6
(3) Slightly low or low reliability region (CV 30 to 40 per cent)	Kaira, Broach, Amreli, Baroda, Panchmahals, Surat, Bulsar, Dangs, and parts of Ahmedabad, Surendranagar, Rajkot and Bhavnavar	38.1
(4) Satisfactory region (CV less than 30 per cent)	Parts of Bulsar	0.8
	Total:	100.0

Areas with less than 30 per cent coefficient of variability are practically non-existent in the State. Over as much as 61 per cent of the State, the rainfall is highly unreliable, and over 17 per cent of the area, it is totally unreliable.

Land Use and Cropping Pattern

4.6 Appendix 4.1 shows the extent of land under different uses in the districts of the State. The total reporting area in the State in 1967-68 was 18.53 million hectares, of which 4.88 million hectares are listed as being either barren or uncultivated or as land put to non-agricultural uses. These categories form 26.3 per cent of the reporting area, as compared to 15.7% for the Indian Union. About 53 per cent of the reporting area has already

been brought under cultivation. Even though the State is deficit in food-grains, more land is not easily available for cultivation. The percentage of area under forests is 8.8, which is very much below the minimum requirement and cannot be further reduced without disturbing the ecological balance in the State. There are, however, culturable waste lands covering 0.51 million hectares and permanent pastures and grazing lands extending over a further 1.01 million hectares. In addition, 0.39 million hectares are under current fallows and 0.3 million hectares under old fallows; most, if not all this land, can be brought under the plough and can significantly increase the cultivated area. The population of the State is 26.69 millions and the per capita cultivated land works out to 0.37 hectare. A marginal increase is possible, if the unutilised areas referred to above are also pressed into use. The gross cropped area of the State is 10.42 million hectares and based on this, the ratio of intensity of cropping works out to a nominal figure of 1.06. The area under multiple cropping is thus extremely low. The common practice in the State, therefore, appears to be the raising of only one crop in a year.

4.7 The cropping pattern of Gujarat is characterised by the predominance of kharif cash crops, millets, and pulses. Of the total area sown, about 48 per cent is under food-grains and pulses, about 22 per cent under oilseeds and 17 per cent under cotton. The principal crops are groundnut, bajra, cotton and jowar, with an area of 1.94 million hectares, 1.87 million hectares, 1.64 million hectares and 1.34 million hectares respectively under these crops during the year 1967-68. The State accounts for more than one-fourth of the total acreage under groundnut in the country. This crop is generally grown in the light soils of the Rajkot division. The State also accounts for more than one-fifth of the area under cotton in the Indian Union. Cotton is taken on heavy soils with a depth of 1 m., and under 50-125 cm. of rainfall. Most of the cotton is produced in southern Gujarat where conditions for raising long staple cotton are excellent. Cotton is generally grown as a rain-fed crop, except in Ahmadabad and Kaira districts, where it is irrigated.

Bajra is mostly a rain-fed crop and is grown on the light soils of the Banaskantha, Ahmadabad, Bhavnagar, Junagadh and Rajkot districts. In some parts, this crop is mixed with tur. Jowar is grown in the heavier soils of north Gujarat and Saurashtra. In Panchmahals, maize takes the place of jowar as the major crop. Even though wheat and rice each occupy far less area than jowar and bajra, yet because of higher yields the production of these crops is sizeable. Wheat is grown in north Gujarat and to some extent in the Saurashtra districts, where the climate in winter suits its cultivation. Rice is an irrigated crop and is grown in the south Gujarat districts of Panchmahals, Kaira, Baroda, Surat and Ahmadabad.

Rice and wheat among food crops and cotton and fodder among non-food crops account for two-thirds of the gross irrigated area in the State. Other crops grown under irrigated conditions are sugarcane, rape mustard and tobacco, but the area under these crops is small. Table 4.4 gives a crop-wise picture of irrigation in Gujarat.

Table 4.4

Area Irrigated, by Crops 1967-68

(Thousand hectares)

Crop	Area irrigated	Irrigated areas as per cent of sown area
Rice	138	27.2
Jowar	36	2.7
Bajra	47	2.5
Wheat	353	63.7
All food grains	605	11.3
Sugarcane	28	100.0
All food crops	785	14.1
Rape & mustard	30	76.9
All oil-seeds	53	2.4
Cotton	208	12.7
Tobacco	23	24.5
Fodder crops	75	8.2
All non-food crops	381	7.8
All crops	1,166	11.2

A significant trend in the agricultural production of the State in recent years has been the increase in food production in spite of a considerable shift in the area from foodgrains to non-food crops. This has been mainly due to improvements in the yield of crops. In view of the limited scope for extending the area under food-grains, the need for intensifying and extending irrigation, for increasing the area under high-yielding varieties, and for multiple cropping is essential.

Appendix 4.2 shows the area under different crops, and the crop pattern in the State for 1967-68, and the area irrigated crop-wise.

Water Resources

4.8 The major rivers contributing to the surface water resources of the State in the Gujarat region are (*i*) the Tapi, (*ii*) the Narmada, (*iii*) the

Mahi and (*iv*) the Sabarmati. In addition, there are a number of smaller rivers flowing through the main-land of Gujarat into the Gulf of Cambay. In Saurashtra, a number of rivers originate in the central highlands and flow into the Arabian Sea and the Gulf of Kutch. The Bhadar and Shetrunji are important rivers belonging to this group. Similarly, in Kutch, there are a number of small rivers which flow from the central highlands into the sea.

All the rivers in the State, except the Narmada and the Tapi, are seasonal. Even in the case of these two rivers the flows are subject to wide variations. For instance, the flow of the Narmada fluctuates, from the high flood discharge of 56,600 cumecs during the monsoon to about 28 cumecs or less in May. All these rivers carry more than 90 per cent of their annual flows during the monsoon months. Table 4.5 gives the drainage area and mean annual run-off in respect of important rivers and river systems in the State.

Table 4.5

Major Rivers of Gujarat

River	States through which the river flows	Total drainage area (sq. km.)	Drainage area in Gujarat (sq. km.)	Mean Annual run-off in m.cu.m.
Tapi	Madhya Pradesh, Maharashtra and Gujarat	65,145	3,835	19,736
Narmada	-do-	98,800	11,400	44,331
Mahi	Madhya Pradesh, Rajasthan and Gujarat	34,840	11,695	11,812
Sabarmati	Rajasthan & Gujarat	21,675	17,550	3,663
Luni and other streams of Kutch and Saurashtra	-do-	321,815	128,420	12,278

The Gujarat region extends over 17 river basins from the Damanganga basin in the south to the Rel basin in the north, and covers 63,500 sq.km. Hydrological observations for the assessment of water resources in this region are carried out by the Water Resources Investigation Division,

Ahmadabad of the Central Designs Organisation of the State. Recently a Water Resources Investigation Circle has been created. A special circle called the Narmada Irrigation Circle looks after work relating to the Narmada. There are, in all, 48 river-gauging stations and 65 rain-gauging stations in this region. However, a State-wise assessment of the available surface resources is yet to be made.

In regard to the Narmada, observations of discharge have been made since 1948 at Garudeshwar, 11 km. below the Navagam Dam Site which is 1,156 km. from the source and 3 km. below the point where the river enters Gujarat. According to an assessment made by the Central Water & Power Commission, with the data available up to 1965, the stream at Garudeshwar has a potential of 26,890 m.cu.m. (21.8 MAF) at 90 per cent dependability, 35,350 m.cu.m. (29.0 MAF) at 75 per cent dependability and 45,640 m.cu.m. (37.0 MAF) at 50 per cent dependability. The catchment area up to Garudeshwar is 87,775 sq.km. How much of the water potential of the Narmada can be used by Gujarat at Navagam is at present one of the points under consideration of a Tribunal.

In the Saurashtra and Kutch region most of the promising major and medium irrigation schemes have either been taken up or completed and the balance of water resources to be harnessed are meagre. No separate organisation for hydrological observations has, therefore, been established there. However, the existing river gauging and rain gauging stations are being manned by the respective divisions and sub-divisions covering the schemes.

4.9 According to the Draft Fourth Plan the total surface water resources of the State exclusive of the Narmada flows are about 51,190 m.cu.m. (41.5 MAF) of which, utilisable flows are 16,650 m.cu.m. (13.5 MAF) or 32.5 per cent. The Narmada Water Resources Development Committee (1965) recommended an allocation of 13,140 m.cu.m. of Narmada flows. The total usable surface water resources of the State would depend upon the actual allocation of the Narmada waters.

Some estimate of irrigation potential in terms of area, can be had from the Fourth Plan document and the Report of the Working Group on Minor Irrigation. The former puts the utilizable surface irrigation potential of Gujarat from major and medium works at 2.15 million hectares, inclusive of the water of the Narmada. This estimate was adopted from the Techno-Economic Survey of Gujarat made by the National Council for Applied Economic Research in 1963 and covered the Narmada, for which an irrigation potential of 0.754 million hectares had been taken. If the Narmada is excluded, the irrigation potential of the State from major and medium works would work out to about 1.4 million hectares. The potential from minor works based on surface sources such as tanks, ban-

dharas etc. has been estimated by the Working Group on Minor Irrigation to be 0.485 million hectares. The total of these two figures indicates the limits to which irrigation can increase if all available flows except the Narmada are tapped through whatever projects are possible. The limit is 1.89 million hectares.

According to the Khosla Committee, which studied all aspects of the Narmada waters after the publication of NCAER's Techno-Economic Survey of Gujarat, the Narmada alone could irrigate about 1.85 million hectares in Gujarat. Further studies on the subject conducted by the State Government subsequently indicate that its irrigation potential would amount to nearly 3.0 million hectares. However, assuming that the irrigation potential of the Narmada is at least as much as indicated by the Khosla Committee, the aggregate irrigation potential from all surface water sources of the State can be reckoned at 3.74 million hectares.

4.10 Sub-soil water is available in the State at varying depths and in varying quantities. Several geological formations have water bearing aquifers of different types. Most of the aquifers, however, consist of unconsolidated material like gravel and sand, sand stones and lime stones. The ground water reservoirs are re-charged, mainly in areas where the percolation of water from precipitation and from streams is substantial.

Lime stones occuring around Junagadh and parts of Kutch vary widely in density, porosity and permeability, and form aquifers of limited potentiality.

The basaltic flows occurring in Saurashtra hold permeable zones provided by intra-trappean beds, and through shrinkage—cracks, fractures and joints. A prominent geological feature of the Saurashtra area is the presence of 'dykes' in the Traps and in the Jurassics, which provide vertical aquifers.

Sand stones and conglomerates are cemented forms of gravel and sand. The Bhuj standstones of the Umia series are the best examples of such aquifers.

Crystalline and metamorphic rocks which occur in parts of Panchmahals and Sabarkantha are relatively impervious and, therefore, have poor aquifers. Where such rocks occur near the surface under fractured and weathered conditions, the shallow aquifers in them are developed by small wells for domestic purposes. Recent explorations in the Sabarkantha district have revealed the occurrence of fresh water in the Himatnagar sandstones in aquifers of limited potential below the Trap.

The Gujarat alluvial tract contains ground water in alternating beds of coarse sand and clays. The previous beds are often lenticular and inconsistent; and the thickness of beds compared to the total thickness of alluvium appears to vary from area to area.

4.11 The Geological Suvey of India has been investigating the possibility of developing the ground water resources in Gujarat. It has conducted field studies, area-wise in the following soil-tracts:

(i) alluvial tracts;
(ii) area underlain by semi-consolidated rocks;
(iii) area underlain by consolidated or hard rocks;
(iv) coastal tracts.

An appraisal of the ground water resources in the above areas is given below:

An area of about 23,300 sq.km. of the alluvial tract, drained by the Sabarmati, Mahi, Dhadhar, Narmada, and Tapi rivers and their tributaries in Gujarat has been studied in detail. The hydrological data, though not complete, indicate that ground water is available near the surface within a depth range of 9 to 24 m.; sub-artesian water between 24 and 61 m. depth; and artesian water from three aquifer zones lying in the depth ranges of 91 to 152 m., 183 to 244 m. and 274 to 366 m. below ground level. The quality of near-surface groundwater is generally potable except when polluted by sea water or by local sewage systems. The sub-artesian zone invariably yields fresh and potable water. The artesian water varies in quality and is usually unpotable but is often used for irrigation. The yield of ground water from all these zones is moderate.

Geohydrological studies in the Umia group of sand-stones (Jurassic) in parts of Surendranagar district indicate that the area could be developed on a moderate scale by means of tubewells drilled to a depth of 150 to 300 m. which are likely to yield about 40,000 litres of water per hour for a draw-down varying from 15 to 46 m.

In the district of Kutch, permeable Bhuj sandstones (Jurassic) form the most prolific water-bearing formation. Studies reveal that the Bhuj aquifers are interconnected, forming a single subterranean reservoir holding good promise for further development. Slight to moderate ground water development is also possible in the soft sandstone members of the Katrol series (Jurassic).

Deccan trap basalts occupy a large portion of Gujarat. Here the inter-trappean formations and the weathered zones within the traps are occasionally found to be water-bearing.

Some bore-holes drilled in the Kutch district indicate the presence of aquifers in the depth range of 91 to 215 m. So far, only a few areas in that district have been found suitable for ground water development. Investigations carried out in the Bhuj-Mankuwa region of the Kutch district show that soft friable sandstones of the upper Bhuj stage and the medium to coarse-grained sandstone members of the lower Bhuj formation are potential ground water reservoirs.

The area around Kandla port and Gandhidham has also been found to

possess scope for ground water development by means of tubewells down to the rocks of the Bhuj series. However, the ground water potential here is limited.

Only some parts of the State such as the Mehsana district, the eastern half of Banaskantha, the western parts of Kutch and parts of Sabarkantha, Panchmahals, Ahmadabad, Kaira, Broach, Baroda, Surendranagar, Jamnagar and Junagadh districts, have so far been covered by the intensive investigations carried out by the Geological Survey of India. More investigations are proposed to be undertaken. Meanwhile, the State Government is planning to undertake detailed ground water surveys in areas which were not covered earlier and has set up a new organisation called the Ground Water Directorate for the purpose.

4.12 Even though a number of studies regarding ground water have been carried out by various agencies, no firm estimates are yet available of the ground water potential of the State. The Draft Fourth Plan prepared by the State puts this potential at about 9,870 m.cu.m. (8 MAF). The National Council for Applied Economic Research had earlier estimated it to be 0.89 million hectares assuming that it would be about twice the extent of irrigation from wells existing at that time. According to the report prepared by the Working Group on Minor Irrigation in connection with the formulation of the Fourth Plan, the irrigation potential from ground water sources in the State is about 1.22 million hectares.

4.13 The total irrigation potential of the State in terms of flows, including both surface water and ground water can thus be placed at 26,520 m.cu.m. (21.5 MAF) exclusive of Narmada flows and at 39,660 m.cu.m. (32.15 MAF) inclusive of these flows. In terms of area, the aggregate potential, excluding the Narmada is 3.1 million hectares, and 4.95 million hectares including the potential of the Narmada. Assuming that the total cultivable area in the State is around 11.00 million hectares, about 45 per cent of this area can be irrigated when the estimated potential is fully realised. If the Narmada's irrigable capacity of 1.85 million hectares is excluded, the irrigable area in the State gets reduced to 28 per cent of its cultivable area.

Present Irrigation Development

4.14 Gujarat is one of the few States in the Indian Union with a low percentage of irrigation. Very little had been done to exploit the irrigation potential of the State from surface sources, and before the commencement of the Five Year Plan, only two or three weir schemes like the Hathmati and the Khari-cut system existed. The reasons for the low irrigation were partly historical, as the area comprised a large number of Princely States

which could not resolve their differences over riparian rights. The States were so small that often a dam site fell in one State, and its command area in another. Most of these States did not have the technical and financial competence to undertake a major project. Moreover, the alluvial plains of Gujarat did not offer suitable sites for dams, headworks etc., these factors explain why, before the advent of planning there was not a single major irrigation project in the State.

Soon after Independence two major schemes viz. the Kakrapar on the Tapi river and the Mahi Right Bank Canal on the Mahi river were taken up in the Gujarat region and four medium schemes viz. Rangola, Brahmani, Ghee and Surajwadi in the Saurashtra region. All these were included as continuing schemes in the State's First Five Year Plan. The First Plan envisaged 33 schemes in all, including the six mentioned above, of which two were major and the remaining medium schemes. Eleven of these schemes including the major schemes, were in the Gujarat area, 17 in Saurashtra and 5 in Kutch. All these schemes have been completed except the two major schemes and the Rudramata Project in Kutch which have spilled over into the Fourth Plan.

In the Second Plan, 26 new projects were taken up, of which six were major and 20 medium. The major schemes were the Shetrunji in the Saurashtra region and Dantiwada, Hathmati, Ukai, Narmada and Kadana in the Gujarat region. The Saurashtra region accounted for 16 of the new projects, the Gujarat region for 7 and Kutch for 3. Half the major schemes and 14 medium schemes have been completed and the remaining 9 have been carried over into the Fourth Plan. The most important schemes carried over from the Second Plan are the Ukai, the Kadana (Mahi Stage II) and the Narmada Projects.

No new schemes were taken up during the Third Plan period due to the large spill over from the first two Plans and the need for the completion of continuing schemes. Similarly no new schemes were taken up during 1966-69, except the preliminary work on one major multi-purpose project on the Sabarmati river, known as Dharoi Storage.

In the Fourth Plan, the State Government is concentrating on the expeditious completion of projects already in hand and providing reservoir support without which they would remain only partially effective. All the continuing schemes are included in the Fourth Plan, which include the major projects of Kakrapar, Ukai, Mahi Stage I, Mahi Stage II and Narmada and a medium project viz. Saraswati in the Gujarat mainland, Dhatarwadi, Kalindri, Goma and Machhu II in Saurashtra area and Rudramata and Gajansar in Kutch. Over 30 per cent of the total outlay proposed in the States Fourth Plan is allocated to irrigation works.

Appendix 4.3 gives details of cost, and irrigation benefits expected from the major and medium schemes taken up under the first two Plans.

4.15 Some salient features of the important projects are indicated briefly below:

Shetrunji (Palitana) Project

The project comprises a masonry dam with earthen flanks and a canal system on either bank to irrigate 34,800 hectares. The reservoir is situated about 10 km. south-east of Palitana town in the Bhavnagar district. The gross storage capacity of the reservoir is 350.3 m.cu.m. with a live storage of 309.6 m.cu.m. The spillway has been designed to discharge a maximum flood of 7,079 cumecs. The project was taken up in 1955 as part of the Second Plan and was completed in 1965.

Banas (Dantiwada) Project

A composite dam has been constructed across the Banas river near village Dantiwada in the Banaskantha district. The maximum height of the dam is 61 m. and the length 4,815 m. of which 327 m. is masonry and 4,488 m. earth. The gross capacity of the reservoir is 464.4 m.cu.m. while the live storage capacity is 445 m.cu.m. The canal system extends over 652 km. to command an area of 44,517 hectares for irrigation. The project was started during the Second Plan and completed in 1969.

Hathmati Reservoir Project

A dam across the river Hathmati near Fathepur village in Sabarkantha district has been constructed about 5 km. upstream of its confluence with the river Indrasi. The gross and live storage capacities of the reservoir are 161.5 m.cu.m. and 154.8 m.cu.m. respectively. The canal system which is 191 km. long irrigates about 37,604 hectares. The total cost of the project is Rs. 54.5 million. Work on the project was started in 1959, and completed during 1968-69.

Bhadar Project

The Bhadar river basin is the largest in the Saurashtra region. The project comprises a masonry dam with earthen flanks and a canal system on the left bank to irrigate 17,200 hectares. The gross storage capacity of the Bhadar reservoir is 238 m.cu.m. with a live storage capacity of 224 m.cu.m. This project was taken up in the Second Plan as a medium irrigation scheme and has been completed at a cost of Rs. 43.3 million. It was the biggest of the medium works undertaken in the State.

Mahi River Development

The development of the Mahi river waters in Gujarat has been planned in stages.

Stage I comprises a pick-up weir on the river Mahi near Wanakbori in Kaira district and a canal system taking off from the right of the weir. The main canal and its branches are over 300 km. in length and will irrigate 0.19 million hectares in Kaira district on completion. Work on this project was started in the pre-Plan period and irrigation commenced on a partial basis during 1958-59. This stage is estimated to cost Rs. 246 million and is likely to be completed towards the end of the Fourth Plan period. The maximum irrigation so far achieved from this project was only 40 thousand hectares or 22 per cent of the potential. This was because run-of-the-river supplies generally dwindled towards the end of the rabi season, and water could not be ensured to the command in the absence of any storage on the river.

Stage II of the Mahi river development consists of the Kadana dam higher up the Mahi river, 71 km. upstream of the Wanakbori weir, in the Panchmahals district, and a canal taking off from the left bank. The Kadana reservoir has a gross storage capacity of 1,700 m.cu.m. and a live storage capacity of 1,300 m.cu.m. Both direct and indirect irrigation benefits are envisaged from the Kadana Project. While the Left Bank Canal is expected to provide direct irrigation to about 16,554 hectares, steady releases of water from the reservoir would stabilise irrigation over 0.27 million hectares of the area under the command of the Mahi Right Bank Canal. Work on the project was started in 1956. It is expected to be completed towards the end of the Fourth Plan at a cost of Rs. 210 million.

In addition to the Kadana dam, the Gujarat Government has also arranged to get a share of the waters stored at Banswada on the Mahi river, higher up in Rajasthan. This was necessary, as hydrological studies indicated that the storage at Kadana would not be sufficient to meet the entire irrigation requirements of the Mahi command areas in Gujarat.

Tapi Valley Development

The Tapi valley development in Gujarat comprises two stages. Stage I is the Kakrapar Project and Stage II the Ukai dam and canals. The Kakrapar Project comprises a pick-up weir constructed across the river Tapi near Kakrapar village in Surat district, about 81 km. upstream of Surat city. The work on the project was started in the pre-Plan period and irrigation from it commenced in 1953-54. The weir is constructed of masonry and the flanks are of earth. The former is 621 m. long with a maximum height of 14 m. The length of the distribution system is 435 km. and 0.23

million hectares a year will be irrigated. Work is still in progress on the distribution system and the project. It is estimated to cost Rs. 180.5 million and be completed towards the close of the Fourth Plan.

Irrigation from the weir scheme so far, has been uncertain because of the paucity of water in the river after the monsoon, and the lack of storage facilities.

Stage II of the Tapi development envisages a composite dam across the Tapi river near village Ukai in Surat district about 116 km. upstream of Surat, and a canal system for irrigation. The dam will be 4,928 m. long, 18 per cent of which will be of masonry and the rest of earth. Its maximum height above the river-bed will be 68.6 m. The gross storage capacity of the reservoir is 8,511 m.cu.m., of which the live storage will be 7,092 m.cu.m. The main canals will have a total length of about 950 km. and extend irrigation over an area of 0.15 million hectares. Besides, the supplies from the Ukai reservoir will also stabilise irrigation on 0.23 million hectares, under the command of the Kakrapar Project. It will also afford flood protection to areas lower down, particularly to the city of Surat. The project is multi-purpose and in addition to irrigation, it will generate about 193 MW of hydro-electric power at 35 per cent load factor. The total cost of the project is estimated at Rs. 1,044 million. Work on the project was started in 1960. Construction of the dam has been completed and it is expected to hold the waters of the Tapi in the 1972 monsoon. Work on the Ukai canal is still in progress.

Narmada Project

The Narmada Project as sanctioned by the Planning Commission envisages the construction of a low dam 2,012 m. long with a maximum height of 69.2 m. above the deepest foundations, near the village of Navagam in Broach district. The initial F.R.L. envisaged was 162 feet but the foundations of the dam were to be laid in such a way as to permit an F.R.L. of 320 feet in the second stage. The canal system 143 km. long, would extend up to the river Mahi and irrigate 0.4 million hectares. The project was given a notional start in the later part of the Second Plan period.

While the preliminary works were in progress at the Navagam site, the Government of Gujarat carried out studies to raise the height of the Navagam Dam with a view to utilize all the available flow in the Narmada realised below the Punasa dam in Madhya Pradesh. The studies indicated that a reservoir with F.R.L. 460 feet would enable the realisation of optimum benefits and would make possible the extension of irrigation to a large area in Gujarat. However, as it would have involved the submersion of the Punasa dam, the Gujarat Government suggested the construction of a dam with FRL plus 425 ft. In this proposal, a high level canal with FRL plus

300 ft. was envisaged as against two canals in the sanctioned project. Proposals were also made for the reclamation of the Little Rann of Kutch.

The construction of a dam of this size involving submersion of lands in Madhya Pradesh needed an inter-State agreement between Madhya Pradesh, Maharashtra and Gujarat but the efforts to achieve it failed. Subsequently, the Government of India appointed a Committee under the chairmanship of Dr. A. N. Khosla to prepare a Master Plan for the development of the Narmada basin. This Committee recommended that the FRL should be 500 ft. for the Navagam dam and the FSL 300 ft. for Narmada canal extending up to Kutch and to the Rajasthan border and beyond. The project as envisaged by the Khosla Committee provided irrigation to 1.85 million hectares in Gujarat and 40,000 hectares in Rajasthan. It would have utilised 13,140 m.cu.m. (10.65 MAF) of Narmada waters. It would also produce some electricity. However, due to the lack of agreement between the Governments of Gujarat, Maharashtra and Madhya Pradesh the work on this project could not proceed. At present, the dispute is pending before a Tribunal, appointed by the Union Government under the Inter-State Water Disputes Act.

4.16 The area irrigated by the canals in 1951-52 in Gujarat was barely 16 thousand hectares. These canals were mostly owned by the Government. The coverage by canal irrigation increased to 40 thousand hectares by 1955-56, 66 thousand hectares by 1960-61, 140 thousand hectares by 1965-66 and 199 thousand hectares by 1967-68. Compared to the pre-Plan period irrigation by canals increased more than 12 fold—a substantial increase by any standards.

4.17 Ground water in Gujarat is extracted through open wells, dug-cum-bore wells, shallow tubewells and deep tubewells. Open wells form by far the largest single means of extracting ground water, since times immemorial. In 1951-52, of the total area of 0.46 million hectares irrigated from all sources, wells accounted for 0.4 million hectares or 88 per cent. A survey conducted by a Technical Committee set up by the Bombay State prior to its division estimated that there were 0.4 million wells in Gujarat State in 1956-57, of which 0.38 million were in use and 0.02 million derelict.

Minor irrigation in Gujarat increased considerably through a dynamic programme of promoting wells and pumpsets. Active steps have been taken by the State Government to encourage cultivators to dig wells and to put up pumps. During the Third Plan period, more than 50,400 new wells were constructed and about 9,700 old wells repaired. The achievements for the period 1966-69 are likely to be of the order of over 54,500 new wells constructed and 9,000 old wells repaired. The total number of wells in the

State at the end of March 1969 was about 0.69 million. Amreli had the maximum of 11 wells per sq. km. followed by Kaira, Mehsana, Sabarkantha, and Junagadh. The five districts of the Saurashtra region viz. Amreli, Jamnagar, Junagadh, Bhavnagar and Rajkot and the five districts of the northern Gujarat region viz. Banaskantha, Sabarkantha, Mehsana, Panchmahals and Kaira accounted for nearly 80 per cent of the wells in the State, more or less in equal numbers.

4.18 Tanks irrigate only a small area in Gujarat. They are more important in the Saurashtra Peninsular tract, which has a generally undulating topography. This region is traversed by a large number of streams, whose flows during the dry season are insignificant. Rainfall in this area is about 50 cm., confined to the south-west monsoon. The only means of increasing the irrigated area, therefore, is through a system of storage tanks. The southern part of Gujarat is comparatively flat. For this reason there are not many tanks there. In all, there were about 1,140 tanks in Gujarat at the end of 1964-65. The tanks irrigated 6,000 hectares in 1951-52, that is to say, a little over one per cent of the total area irrigated from all sources. The area under tank irrigation increased to 25,000 hectares in 1955-56, and further to 34,000 hectares in 1967-68. Tanks now account for nearly 3 per cent of the total irrigation from all sources.

4.19 The State has made good progress with tubewell irrigation. Before 1950, there were only 27 tubewells in the State, all located in the district of Mehsana. The number increased to 407 by the end of the First Plan, to 638 by the end of the Second, to 1,034 by the end of the Third and to 1,049 by the end of March, 1969. In addition, there were 778 tubewells owned by individual farmers or cooperatives. The largest concentration of tubewells is in Mehsana district, followed by Ahmadabad, Kutch, Banaskantha and Kaira in sequence. In 1967-68, nearly 46 thousand hectares were irrigated by tubewells i.e. 4.1 per cent of the total irrigation in the State.

The total area irrigated by wells of all types including tubewells, was 0.86 million hectares in 1965-66, compared to 0.57 million hectares in 1960-61 and 0.4 million hectares in 1951-52. The increase in well irrigation in 1965-66 over the pre-Plan figure was 115 per cent.

4.20 Table 4.6 indicates the area irrigated by different sources in the State in 1965-66 compared to 1951-52 and also the percentage of increase in irrigation over the period.

The extent of the irrigated area in Gujarat increased by about 143 per cent in the period from 1951-52 to 1967-68, the most significant increase being in canal irrigation. The relative proportion of the canal irrigated area increased from 3.5 per cent in 1951-52 to 18.0 of the total in 1967-68.

Table 4.6

Area irrigated in Gujarat: source-wise

(Thousand hectares)

Source	1951-52	1967-68	Percentage increase in 1967-68 over 1951-52
1	2	3	4
Ground Water			
Wells			
Tubewells	NA	46 (4.2)	NA
Open wells	NA	820 (74.0)	NA
Total:	402 (88.2)	866 (78.2)	115
Surface Pources			
Government	15 (3.3)	198 (17.9)	1220
Private	1 (0.2)	1 (0.1)	—
Total:	16 (3.5)	199 (18.0)	1444
Tanks	6 (1.5)	34 (3.0)	467
Other sources	32 (7.0)	9 (0.8)	(—) 72
Total:	456 (100.0)	1108 (100.0)	143

(Figures in brackets indicate the relative contribution of each source to irrigation).
NA—Not available.

The area irrigated by tanks increased five times and that by wells and tubewells more than doubled during the same period. According to available information, 0.11 million hectares or 11 per cent of the irrigated area were covered by major and medium irrigation works in 1965-66 and the remaining by minor irrigation works.

4.21 Table 4.7 gives the area irrigated in the State in 1967-68 district-wise:

In Gujarat, only 11.3 per cent of the net cultivated area is under irrigation, compared to 19.7 per cent in the Indian Union. Inside the State, this proportion varied from almost nil in Dangs to 24.3 per cent in Mehsana. Kaira and Junagadh also enjoy fairly good irrigation facilities compared to other districts. Wells are the main source of irrigation in all districts

Table 4.7

District & Source-wise Irrigation in Gujarat—1967-68.

(Thousand hectares)

District	Canals	Tanks	Wells	Others	Total	Percentage net irrigation to net sown
1	2	3	4	5	6	7
Ahmadabad	25.9	5.2	52.0	2.0	85.1	13.9
Banaskantha	2.1	0.8	102.5	—	105.4	12.7
Baroda	3.8	5.2	45.4	1.3	55.7	10.3
Broach	1.4	0.8	29.7	2.4	34.3	7.5
Dangs	—	—	0.1	—	0.1	0.2
Kaira	42.8	4.2	63.8	1.0	111.8	21.4
Mehsana	6.0	1.0	162.4	0.3	169.7	24.3
Panchmahals	4.1	2.8	9.7	—	16.6	3.5
Sabarkantha	1.4	0.4	55.2	0.3	57.3	12.7
Surat	39.0	3.1	12.9	0.5	55.5	12.4
Bulsar	5.3	5.6	11.7	0.3	22.9	7.8
Amreli	3.0	0.3	30.1	—	33.4	6.7
Bhavnagar	10.6	—	44.3	—	54.9	8.8
Jamnagar	5.7	—	44.9	—	50.6	8.5
Junagadh	3.9	—	85.6	—	89.5	15.3
Kutch	9.5	—	32.5	0.1	42.1	6.5
Rajkot	25.0	3.0	53.2	0.2	81.4	11.0
Surendranagar	9.4	1.5	21.9	—	32.8	4.9
Gandhinagar	—	—	8.2	0.8	9.0	17.3
Total:	198.9	33.9	866.1	9.2	1108.1	11.3

except Surat, where they irrigate only 23% of the irrigated area, while the contribution of canals is about 70 per cent. Other districts where canal irrigation is important and covers 25 per cent or more of the total irrigated area, are Rajkot, Ahmadabad, Panchmahals, Surendranagar and Kaira. Tanks are an important source of irrigation only in Bulsar.

Ayacut Development

4.22 The two biggest irrigation projects undertaken in the State after Independence are the Mahi-Kadana and the Kakrapar-Ukai. The development of the ayacut under both these projects has been rather slow, the principal reason being that these projects were initially constructed as diversion schemes. As explained in paragraph 4.15 above, under the Mahi-

Kadana Project only the Wanakbori weir and the canal system were constructed in the first instance. The flow in the Mahi is highly fluctuating and particularly low in the rabi season, and the development of the ayacut has been slow. Rainfall in the command area is also fairly good, and the farmers do not have the urge for irrigation. The picture in respect of the Kakrapar Project completed in 1953 is very much the same. The rainfall in the Kakrapar command is also good in the kharif season and this factor accounts largely for the slow rate of ayacut development. With the construction of storages/reservoirs at Kakrapar and Ukai, the development of irrigation in the command of these two river systems is likely to pick up.

The Gujarat Government has been assisting the farmers to level their lands and to take to improved methods of agriculture in the irrigated areas, by advancing financial assistance under the Bombay Land Improvement Scheme Act 1945. It has also been taking an active interest in the construction of water courses in the command areas and in the lay-out of field channels etc.

In the rest of the State, particularly in Saurashtra, there has been practically no delay in the development of irrigation. The farmers in these parts are keen to use irrigation water in their fields as soon as it is made available.

There is no separate administrative set-up in Gujarat for ayacut development. However, there is a High Level Official Committee under the Chairmanship of the Additional Chief Secretary to supervise and guide the work of developing the Mahi-Kadana and Kakrapar-Ukai commands. A Project Coordinator has also been posted in the Mahi-Kadana Project for coordinating the work of different departments in the project command.

We were happy to find that the Agriculture Department, through its Soil Conservation Wing, which, in Gujarat, is, *inter, alia* responsible for the construction of field channels, is carrying out experiments in lining field channels. It was explained to us that where farmers had not constructed the field channels, themselves the Agriculture Department does it on their behalf, and recovers the cost from them under the provisions of 'The Land Improvement Schemes Act'. A welcome feature of the system is that the channels are made to take irrigation water to every field within the command.

Drought Affected Areas

4.23 Gujarat has suffered famine and scarcity in 23 of the 71 years of the present century. The country-wide drought of 1965-66 and 1966-67 affected five to six thousand villages in the State and conditions in 1,500-2,500 villages were particularly bad. In the 1968-69 drought, 8.8 million

people in 10,000 villages were affected; in 6,000 villages the situation was acute.

The extreme unreliability of the rainfall, particularly in north Gujarat, Saurashtra and Kutch is the main cause of drought.

A fact-finding committee set up in 1958 by the erstwhile Government of Bombay had identified parts of Banaskantha, Panchmahals, Mehsana, Kutch, Kaira, Jamnagar, Bhavnagar, Amreli, Surendranagar, Broach and Ahmadabad districts as chronically drought affected. In reply to our Questionnaire, the State Government has included some more areas in Kutch under the drought affected category. In all, about 40 per cent of the land area in Gujarat is considered to be susceptible to drought.

The drought areas (taluks) in the State as identified by the Commission are listed in Appendix 8.1 of Volume I. These areas comprise about 36 per cent of the State's area and 27 per cent of its population (1961 Census). There is great agreement between the classification attempted by the State and that by the Commission. The criteria adopted by us in identifying drought affected taluks have been explained in Chapter VIII of Volume I.

Although many major and medium irrigation schemes have been taken up in the drought affected area, there has been unfortunate delay in the completion of some of these projects. Important among the projects in drought areas are Narmada, Mahi Stage I, Mahi Stage II, Saraswati, Machhu II, Rudramata, Dhatarwadi, Goma and Gajansar.

The Gujarat Government has reported that four-fifths of the gross command of the Narmada High Level Canal would benefit the scarcity areas and 50 per cent of the problem in north Gujarat would be solved when this canal is built. There are also a few other irrigation schemes under investigation or under consideration by the Government. The more important among them which are likely to irrigate more than a thousand hectares each in drought areas are:

(1) Dharoi Reservoir
(2) Sipu Reservoir
(3) Delna Inundation Scheme
(4) Baldeva
(5) Karjan Reservoir
(6) Shingonda
(7) Bagad
(8) Ung
(9) Phophal
(10) Nyari
(11) Vinu II
(12) Sukhbhadar
(13) Nara
(14) Mitti

The Commission recommends that an early investigation of these schemes should be taken up.

The most serious problem in the drought-affected areas of Gujarat is the lack of drinking water. Most of the villages in the scarcity areas have no permanent source of drinking water. In the course of our tour, we came across a number of villages, particularly in Kutch, where the only sources of drinking water for the people and cattle are surface tanks and shallow dug-wells. This water is highly unhygeinic. The problem of providing potable drinking water is, therefore, of the highest importance. We were told that the Narmada High Level Canal, on completion, will provide drinking water to a sizeable portion of the scarcity areas in Gujarat, and that it would improve the ground water position.

Future Development of Irrigation

4.24 The future efforts at the development of irrigation in Gujarat may be broadly classified as:

(i) The early completion of schemes in hand;
(ii) The construction of the Narmada High Level Canal Project; and
(iii) Further ground water development.

4.25 There are twelve major and medium projects which are under construction, at present. They are Tapi Valley Development Stages I & II, Mahi Project Stages I & II, Narmada Project, Rudramata, Saraswati, Machhu, Dhatarwadi, Kalindi, Gajansar and Goma projects. Brief particulars of some of these projects, as given by the State Government in reply to our Questionnaire, are given below:

Rudramata Project

The project envisages the construction of an earth dam across the Pus river, 15 km. north of the town of Bhuj in Kutch with a canal system to irrigate about 7,200 hectares on both sides of the river. This is a medium project, estimated to cost about Rs. 10.6 million. Work on the project was started in 1959. It is expected to be completed during the Fourth Plan.

Saraswati River Scheme

The project envisages a barrage-cum-bridge across the Saraswati river near the town of Patna in Mehsana district and a canal system to irrigate about 8,740 hectares of area in the same district. Its estimated cost is Rs. 21.2 million and it is expected to be completed during the Fourth Plan period.

Machhu Irrigation Scheme

This scheme is expected to benefit Rajkot district to the extent of 7,700 hectares. The project envisages an earth dam on the Machhu river near Morvi in Rajkot district. The revised estimate of cost is Rs. 21.4 million. Work on the project was started in 1961 and is expected to be completed during the Fourth Plan.

The other four medium schemes on which work is progressing during the Fourth Plan are the Dhatarwadi Irrigation Project in Amreli district, Kalindri Project in Junagadh, Gajansar Project in Kutch and Goma Project in Bhavnagar.

The estimated cost of the twelve projects mentioned above is about Rs. 2,856 million of which about Rs. 880.5 million had been spent up to the end of 1968-69, leaving a sum of Rs. 1,975.5 million to be provided for in the Fourth Plan. But the Fourth Plan has made a provision of only about Rs. 783.1 million for these schemes. This meets the full requirement of all the medium schemes and also most of the requirement of the Mahi Stage I and Stage II projects. The project most inadequately provided for is Narmada, but the final scope of it has not been determined yet.

4.26 The following new projects have been proposed by the State Government.

Sabarmati Reservoir Project (Dharoi)

Ahmadabad city is expanding very fast and the present system of water supply to the city from infiltration wells in the river bed and from tubewells has been found to be inadequate. The necessity for a reservoir on the Sabarmati river at Dharoi in Mehsana district has gained in urgency. Gandhi Nagar, the new capital of Gujarat, will also need assured water supply. The reservoir will also stabilise irrigation on about 28 thousand hectares under the old Moti Fatehwadi Canal System. Besides, 40 thousand hectares of land in Mehsana district and 7.5 thousand hectares in Sabarkantha district will also receive irrigation benefits. The reservoir will also afford partial flood protection to areas below it. The estimated cost of the project is over Rs. 180 million. Preliminary work on it was started in 1966-67 but the project has yet to receive the sanction of the Planning Commission.

Damanganga Project

This is a multi-purpose project which besides benefiting portions of Bulsar district will also benefit the enclaves of Dadra and Nagar Haveli.

It can irrigate an area of 45.2 thousand hectares, including about 7,000 hectares in the Dadra and Nagar Haveli enclaves.

Sipu Project

This project will be located in Banaskantha district. It is estimated to cost over Rs. 50 million and will benefit an area of 23,310 hectares on the fringe of the drought affected area.

Panam Reservoir Project

This project is located in Panchmahals district and is capable of irrigating 16,500 hectares. Its estimated cost is about Rs. 100 million.

Watrak Project

This project will be in Sabarkantha district and can irrigate 22,100 hectares in the district and some parts of Kaira district. Its estimated cost is around Rs. 30 million.

The State Government have investigated 4 more major irrigation projects and 63 medium projects. The additional irrigation anticipated from these projects is about 0.39 million hectares and the estimated cost Rs. 1,713.6 million. If all these schemes are found feasible and are taken up for implementation, the aggregate potential created in the State, excluding the Narmada will be of the order of 1.33 million hectares, which is very close to the overall limit of 1.4 million hectares, in respect of major and medium schemes. The projects estimated to cost about Rs. 10 million or more are indicated in Table 4.8.

Reclamation of the Rann and Banni Areas of Kutch

4.27 The Rann of Kutch is a vast, dessicated plain in Gujarat, baked by the sun and blistered by the saline incrustations due to the ingress of sea water. Encircling the mainland of Kutch on the north, east and south, this great salt waste covers an area of over 20,720 sq. km. It consists of two parts, that is the Great Rann in the north and the Little Rann in the south, joined by a narrow strip of land 6.4 km. wide. The former covers an area of 16,835 sq. km. and the latter 3,885 sq.km. The Great Rann is of strategic importance because the international boundary between India and Pakistan runs along the north border of this area for more than 400 km. The few inhabitants live on the two islands of Khadit and Khadva.

After the mainland, Banni is the most important region of Kutch, and

Table 4.8

Future Major and Medium Schemes Costing about Rs. 10 Million or more each, Proposed by the Gujarat State Government

Project	Type	Estimated cost (Rs. million)	Estimated benefits (Thousand hectares).
1	2	3	4
Daman Ganga	Multi-purpose	236.00	45.20
Sipu	Storage	59.50	25.30
Panam Reservoir	-do-	101.10	21.87
Watrak Reservoir Project	-do-	29.20	14.60
Orsang Reservoir	-do-	100.87	—
Heran Reservoir	-do-	87.48	—
Karjan Reservoir	-do-	156.56	64.80
Zankhari Reservoir	-do-	50.00	23.50
Kelia Project.	-do-	11.67	15.04
Amba Reservoir	-do-	43.65	2.76
Manivenial Project	-do-	249.78	5.30
Dali	Pick-up weir	16.80	—
Manala Dam	Storage	71.66	2.76
Mazam Irrigation Scheme	-do-	22.30	7.91
Guhai Reservoir Project	-do-	20.00	9.00
Sukhi Reservoir Project	-do-	44.51	20.30
Sukhbhadar Irrigation Scheme	-do-	9.97	1.24
Shingoda Irrigation Scheme	-do-	14.39	5.40
Hiren Irrigation Scheme	-do-	9.97	1.24
Kalubhar Irrigation Scheme	-do-	15.80	—
Chaparwadi/Jetpur Irrigation Scheme	-do-	10.06	2.90
Phophal Irrigation Scheme	-do-	16.55	4.06

covers an area of 2,500 sq.km. It is a low table land formed by the detritus brought down by rivers flowing on the southern borders of the Rann. The soils are alluvial and sandy loam in texture. Banni is inhabited by nomadic cattle breeders.

The whole area of Kutch, including the Rann and Banni, receives scanty rainfall, and even that is subject to wide margins of variability. In every cycle of ten years, there are 2 to 4 years of acute scarcity and 4 to 5 years of moderate scarcity.

The Government of India adopted a number of measures for the development of Kutch, particularly, in the border areas of strategic importance. However, those measures could not make any headway for want of ade-

quate supplies of water to reclaim land. Before Partition there were some proposals to bring the Indus waters to the Banni and the Great Rann, through a feeder canal from the Hajipur Barrage across the lower Indus. These proposals have now lost their relevance.

Since 1947, the feasibility of reclaiming the Rann of Kutch has been examined by a number of agencies including the IARI. The study made by the IARI indicated the possibility of reclaiming extensive areas in the Banni and in the Ranns. A Study Team, constituted by the Union Ministry of Food & Agriculture in 1965-66 studied the question in greater detail. It reached the conclusion that it was possible to reclaim the Banni and other areas in the Great and Little Ranns if the water of the Narmada river could be made available in adequate quantity. In the Banni area alone about 0.1 million hectares could be reclaimed and irrigated and this would significantly augment agricultural production. The region has vast potentialities for the development of pastures and for the dairy, forestry and salt industries. However, the whole scheme is linked up with the Navagam Project on the Narmada. The future of Kutch would depend on the allocation to the State of the Narmada flows.

Minor Irrigation Works

4.28 Irrigation works such as wells, bore-wells, tubewells etc. utilising ground water, as well as tanks and small bandharas for conserving surface flows, comprise the broad category of minor irrigation works in the State. They form the major source of irrigation. On the introduction of Panchayati Raj, all minor irrigation works were transferred to District Panchayats. During 1967-68 about 80 per cent of the irrigation in the State was accounted for by minor irrigation works. We have indicated, earlier, that wells form the most important single source of irrigation in Gujarat, not only in the minor works but among all sources. The increase in the area irrigated by minor works over the pre-Plan period had been indicated earlier. The current role of these works, the scope for their further expansion and the problems to be solved to achieve accelerated progress are briefly indicated below.

4.29 Wells command nearly four-fifths of the irrigated area of the State. Of late, there has been a significant improvement in the method of utilising these wells. A large number of farmers have taken to modern lifting techniques. Oil engines and electric pumps are fast replacing traditional methods of lifting water, such as Persian wheels, motors etc. During the Third Plan period, against a target of 25,000 pump sets, oil engines and electric motors, 48,000 had been installed. During 1966-69, another 43,400 pump sets were installed. The number of wells with pump sets installed up to 1966-67 was

about 1,27,000. Additions in the subsequent two years would mean that more than one-fifth of wells in Gujarat had been fitted with pumpsets by the end of 1968-69.

At present, greater emphasis is being laid on the electrification of pumps. It is estimated that over 48,000 pumpsets had been electrified by the end of 1968-69. These figures reveal that the programme of installing and energising pumpsets has become popular with farmers. In the Fourth Plan it is proposed to construct 86,500 new wells and to energise 60,000 pumpsets.

The ground water supply in most parts of the State, particularly in Saurashtra, is uncertain. Most of the wells in the State are shallow, and fail in the summer months. Consecutive failures of the monsoon cause many of these wells to dry up. This problem is particularly acute in the Saurashtra region. Wherever ground water supplies are precarious, steps have to be taken to augment them by building percolation tanks and check dams on streams, rivulets and nallas. Contour bunding to help the retention of moisture in bunded fields, and in the sub-soil, should also be encouraged. The State has drawn up a programme of constructing check dams, and Rs. 50 million have been provided for the purpose during the Fourth Plan period. In rocky areas, the tapping of ground water has to be done by boring and blasting. Farmers need special assistance to perform such operations.

Another major difficulty being faced in the well extension programme, is the lack of hydrological data on a scale necessary to provide guidance in the siting of wells. Nowhere is the need for a comprehensive and systematic survey of ground water resources as acute as in the western regions of the State.

4.30 The State has made good progress in tubewell irrigation since 1951-52. In the pre-Plan period there were very few tubewells in the State but thanks to the efforts made under the successive Plans, a large number of tubewells have been drilled in the State Sector. Their number had risen to over a thousand at the close of 1968-69, irrigating over 40,000 hectares of land. In addition, 778 tubewells were drilled by private individuals or by cooperatives, mainly in Ahmadabad, Banaskantha, Mehsana and Kaira districts. Dearth of experienced contractors to undertake the work of drilling, and the difficulty in obtaining foreign exchange for importing drilling rigs had been a drag on this programme in the past.

Investigations carried out by agencies like the Geological Survey, the Exploratory Tubewells Organisation and the State PWD have revealed that four districts viz. Banaskantha, Mehsana, Ahmadabad and Kaira offer good prospects for tubewells irrigation. Baroda and Broach also show promise. The chances are poorest in Panchmahals district.

During the Fourth Plan period, the State proposes to construct 1250

tubewells, nearly half of them in the command of canal irrigation projects, to provide supplemental irrigation facilities and prevent waterlogging.

Up to March 1969, only 705 tubewells had been electrified in the State. The target of electrification in the Fourth Plan period is 300. Liberal loans are being provided to the Gujarat Electricity Board to expedite the programme.

In some parts of the State, particularly in the Mehsana district, the water table has shown signs of receding because of the large number of tubewells operating in the area. In some blocks of this district the drop in the water level was as much as 14 m. About 100 pumps in the district had to be either changed or lowered, in 1968 alone. The experience of Mehsana highlights the need for a careful regulation of the exploitation of ground water through tubewells and for the adoption of suitable measures to recharge the aquifers. It also points to the need for measuring and recording ground water levels for all areas in the State. As the State has an ambitious programme of tubewells under the Fourth Plan to double the present numbers, ground water studies should be completed without delay.

4.31 Out of the 1,142 tanks in the State at the end of 1964-65, only 294 tanks or 26 per cent, were in good shape; most of the others were working partially; or were derelict. A good proportion of the partially working tanks went out of use during 1965-66 and only 588 remained in full, or partial use. These figures reveal how unreliable these tanks are for irrigation. It is no wonder that the progress of minor irrigation through tanks and bandharas fell short of the target. Against the target of 27,520 hectares, the achievement was only 16,600 hectares.

Tanks which irrigate 100 hectares or more are classified as first class, while those irrigating less than 100 hectares are classified as Himayati or second class. Both these categories are looked after by the panchayats. The repair, maintenance and operation of these tanks are carried out by the panchayats. In view of the fact that a large number of these tanks are falling into disuse by siltation etc. their immediate renovation deserves priority.

4.32 The planning of minor irrigation programmes should be tailored to suit conditions in different areas. In the northern areas bordering the arid tracts of Rajasthan, where subsoil water extraction through tubewells and open wells is in vogue, large scale subsoil water conservation measures to recharge the aquifers should be taken up, so that the aquifers are not over-strained. In the western parts of the State, where rainfall is meagre and the run-off faster because of the undulating nature of the terrain, measures intended for conserving water in the sub-soil and on the surface should receive priority. In the southern parts, where rainfall is fairly good and where there are tracts of black cotton soil, irrigation needs to be provided

only for rice and a few specialised crops. Streams with adequate dry weather flows supplement supplies from open wells, which exist in large numbers. It should be possible to realize the potential in full, through the various schemes suggested above.

Floods, Waterlogging and Drainage

4.33 Although Gujarat has large arid or semi-arid areas, the State is often faced with menacing problems of floods. The flood of 1968 of recent memory was unprecedented in the extent of havoc and devastation caused.

Floods occur in Gujarat at somewhat longer intervals but when they occur they cause immense damage. The flood discharges of the Tapi and Narmada are comparable with those of other great rivers of the country. These rivers are also subject to flash floods which bring down huge quantities of silt. The mouths of rivers get silted up and later on the flood waters show a tendency to rise even though the total flood discharge remains the same or is even less than before. Due to the silting of the river by 1968 floods, a later flood of lower intensity raised the flood level higher by 0.9 m than what it would have been, if the bed had not silted.

A pilot programme of soil conservation and flood control has already been taken up in the upper reaches of the Dantiwada Project and the State plans to undertake similar works in other areas. Since the major parts of the catchments of the big rivers like the Tapi, the Narmada and the Mahi lie in the neighbouring States, effective flood forecasting or flood control measures would have to be taken in a coordinated manner in effective cooperation by all the States concerned. The long term solution of the problem of floods as we have pointed out in Chapter XIII of Volume I of our Report would include provision of terminal reservoirs on these rivers, with adequate flood cushions. On the completion of the Ukai Dam in the Tapi basin, it is expected that irrigated areas in this basin will be largely protected from flooding. A scheme for constructing protective bunds on the banks of the Tapi near Surat, to prevent the flooding of the adjoining irrigated areas has been prepared, and is under the consideration of the State Government.

4.34 The problem of waterlogging in the irrigated commands of projects is not severe, mainly because the State has very little perennial irrigation. A few cases reported under the Kakrapar system were remedied by constructing new drains and clearing existing drains. In the commands of some major projects like Kakrapar and Mahi Stage-I, there are proposals for the construction of surface drains to remove water from waterlogged areas.

4.35 Problems of drainage are faced in the northern parts, of the State

generally in the flat districts of Banaskantha, Mehsana and Ahmadabad. Lands in the central alluvium belt of Kaira and Broach have only a nominal slope and because of this the natural drainage is insufficient and requires the construction of artificial drains. Some drains have already been constructed to save land in the catchments from inundation and waterlogging. Drains are a part of minor irrigation, and are the responsibility of District Panchayats. Lump-sum grants for the maintenance of minor irrigation include funds to maintain the drains. But the upkeep of drains appears to have received little attention compared to other minor irrigation works. In this connection we would draw the attention of the State Government to Chapter XIII, Volume I of our Report where we have recommended the steps which should be taken to deal with drainage problems.

Criteria for sanctioning Minor Irrigation Works :

4.36 Different criteria have been prescribed for sanctioning minor irrigation works like (i) storage tanks; (ii) weir schemes; (iii) percolation tanks, and (iv) check dams. Special consideration is given to such works in the backward and drought affected areas.

The criteria for sanctioning storage schemes in the districts of Kutch, Banaskantha, Surendranagar and Jamnagar, is that the cost should not exceed Rs. 3,707 per hectare (Rs. 1,500/- per acre). The following taluks of other districts are also included in the same category:

Name of the District	Name of the Taluk
1. Mehsana	Harij, Sami
2. Ahmadabad	Dhandhuka
3. Panchmahals	Dohad, Zalod, Santrampur
4. Bhavnagar	Botad, Gadhada
5. Rajkot	Jasdan, Wankaner
6. Amreli	Rajula, Lathi, Dhari and Khambha.

In the rest of the State the cost per hectare is limited to Rs. 3,089 (Rs. 1,250 per acre).

The benefit-cost ratio for such schemes should not be less than 1.25. The criterion for weir schemes has been fixed at 50 per cent of that for storage schemes, viz. Rs. 1,850/- per hectare (Rs. 750/- per acre) for the four districts and specified taluks of the remaining districts and Rs. 1,545/- per hectare (Rs. 625/- per acre) for the remaining areas. This limit, however, is relaxed in the case of schemes taken up in backward and chronically drought affected areas. The minimum benefit-cost ratio prescribed for such schemes is the same as for storage tanks viz. 1.25.

For percolation tanks, the criteria are that the cost per 0.028 m.cu.m. of storage should not exceed Rs. 15,000/- and that the total cost of any scheme should not exceed Rs. 0.2 million. As regards check dams, the ceiling on the cost is generally Rs 0.1 million and the benefit-cost ratio not less than 1 (unity). Recently the State Government has relaxed the limit of Rs. 0.1 million for the check dams. Government sanctions grants to cover 90 per cent of the estimated cost of these works, and the remaining 10 per cent is contributed by the District Panchayats, Taluka Panchayats and the beneficiaries. Although Panchayats are permitted to undertake the construction of a percolation tank if its cost exceeds Rs. 15,000/- per M.cft. of water stored, the governmental assistance is limited to Rs. 13,500/- per M.cft. and any additional cost has to be borne by the Panchayats. In scarcity areas, the cost criterion is further relaxed and any medium or minor irrigation scheme can be taken up to provide relief by way of giving employment, irrespective of cost.

Water Rates and Betterment Levy

4.37 The Irrigation Acts of Gujarat provide for the levy of the following charges:

(i) Water rates;
(ii) Irrigation cess; and
(iii) Betterment levy.

Water rates for flow irrigation are charged per acre and not on the volume of water consumed. On tubewells, however, the rates are composite, namely, volumetric as well as area-wise. The water rates have not been combined with land revenue except on 'himayat' tanks which are under the charge of village panchayats. The rates prevailing in the State are indicated in Appendix 4.5. The rates are Rs. 17 per hectare for maize, bajra and jowar during kharif, Rs. 37 per hectare for groundnut, Rs. 44 per hectare for cotton, Rs. 49 per hectare for tobacco, Rs. 44 to Rs. 62 per hectare for rice and wheat and Rs. 346 to Rs. 371 per hectare for sugarcane. Generally, no concessions are given in water rates during the development period except that when canals are put first into operation, foodcrops and fodder are charged for at half the existing rates during the 1st year. The water-rates were revised in 1968. A proposal to raise the existing rates by a common percentage is under the consideration of the State Government.

Over and above the water rates, the State charges a cess, known as the 'Irrigation Cess' on all culturable areas under the command of irrigation works. The cess is leviable after the expiry of 2 years from the date on which the canal begins to supply water, and is uniform throughout the State. It is charged irrespective of whether water is actually used by cultivators or not. The present rate is Rs. 2.5 per acre per annum. An alternative

system of charging irrigation cess on areas that are actually irrigated, as in Maharashtra, is under the consideration of the Government.

The Bombay Irrigation Act contains a provision to charge betterment levy on all the lands under the irrigable command. It provides that 50 per cent of the increase in the cost of land, due to the introduction of irrigation should be charged as betterment levy. However, due to certain administrative difficulties, it has not been possible to collect the levy. The matter was referred to a Special Committee, which has recommended that 40 per cent of the total pooled capital cost of various irrigation schemes in the State should be recovered from the irrigators of lands in easy instalments over a period of 13 years. An amendment of the Irrigation Act on the lines of the Committee's recommendations is under the consideration of the State Government.

Tours, Observations and Impressions

4.38 We visited the State from the 12th to the 18th of April, 1971, beginning the tour from Ahmadabad, where we held fairly detailed discussions at a meeting attended by the Additional Chief Secretary, the Secretaries of the Departments of PWD, Agriculture and Revenue, the Chief Engineer of Irrigation, the Director of Agriculture and other senior officers of the Gujarat Government. The State Irrigation Chief Engineer accompanied us throughout the tour and at a number of places including Baroda, Nadiad, Bhuj and Rajkot, we were able to hear the views of the Members of Parliament, M.L.As., District Panchayat Chairmen and progressive farmers, at meetings arranged for the purpose. We also met groups of Maldharis in the Banni area at Bhindriala and Khavada. We availed ourselves of the opportunity to see the Rann of Kutch and to study at first hand the conditions prevailing there.

Our visit covered some areas within the command of the Mahi Project, the Navagam dam site on the Narmada, Kutch, including the Banni area, Saurashtra and the district of Mehsana. Our observations and impressions of the tour are briefly indicated below.

Narmada Waters

4.39 Wherever we went, and at whatever meetings were held, we were made keenly aware of the strong conviction of the people, that any significant improvement in the irrigation picture of Gujarat, particularly of the scarcity areas in Saurashtra, Kutch and north Gujarat, can only be brought about by irrigation from the Narmada. Our visit to the scarcity areas brought home to us the urgency of providing irrigation there, and we are quite clear in our minds that, irrespective of what share of the Narmada waters

might come to Gujarat, the first priority in the use of this water must be given to these areas where the rainfall is scanty and irregular, rather than to Broach and Baroda districts which have 762 mm of assured rainfall. The benefits from the use of this water in the areas of north Gujarat, Saurashtra and Kutch will be far greater than what would accrue in the two districts mentioned above. There will also be indirect benefits from the replenishment of the sub-soil water which will help the farmers to raise more than one crop each year. As a long-term prospect, we can envisage a beneficial change in the ecology of the area by the introduction of irrigation and afforestation. The precious waters of the Narmada, if and when they are led into the area, will have to be most economically used. It means that canals, distributaries and channels will have to be lined and that priority will have to be given to the growing of kharif crops.

The Banni Area of Kutch

4.40 All the land in this essentially pasture land belongs to the Government, and the Maldharis, a pastoral people who inhabit the area and raise fine herds of cattle, enjoy unrestricted grazing rights. We were told that there were as many as 13 Maldhari clans living in more than forty villages, which have seasonal sources of water for drinking by human beings and herds of cattle. Our visit to the area took place in a year when the rains had been exceptionally good, and it was possible, therefore, to see more grass than is usually found in the area. The quality of grass was enough to give an idea that the soil was good and of what would happen when the area received irrigation water. If some source of irrigation could be found, the possibilities for growing crops and raising cattle would be immense. We felt greatly distressed to hear from the spokesmen of the Maldharis, of the dire distress caused to them, and of the decimation of their herds when, as frequently happens, the rains fail. Then the Maldharis have no option but to migrate hundreds of km outside Banni to save their cattle.

Since scanty rainfall is the rule and good years an exception, we would suggest that urgent measures be taken to conserve whatever rain falls in Banni. Wherever possible, water should be impounded in tanks and we would suggest that in these areas the land can be divided into compartments and enclosed within earthen bunds to arrest the run-off of rain water. All the land belongs to the Government and there should be no administrative difficulties in doing this. We feel that the cost of these bunds should be borne by the Government. This conservation of rainfall will certainly help in developing pasture lands and, in a year of good rain, crops may be raised.

To counter the desiccating effect of the hot winds which sweep Banni,

we would suggest the planting of trees in a north-south direction to serve as wind-breaks.

At a meeting held at Khavada in the Banni area, the graziers gave a long list of streams adjacent to their villages on which small check-dams could be constructed. We would suggest that as many check-dams as are feasible should be constructed. We were given to understand that some of these dams had actually been taken up as scarcity relief works in the recent past, but that once the scarcity was over, the works were abandoned, incomplete, largely for lack of funds.

We would recommend the early completion of these works and further that, in future, any work of this nature, which is taken up as a relief work, should be brought to completion and not be left half-finished.

Ground-Water Development

4.41 Our attention was pointedly drawn to the dilemma faced by cultivators in some areas of the State, like Mehsana and Banaskantha, where canal water is not available and excessive withdrawals had been made from ground-water reservoirs. These withdrawals had already led to a serious and potentially dangerous drop in the water levels in Mehsana district, where about 500 tubewells are operating. The drop in some wells has been as much as 18 m. We were told that semi-submersible pumps had been installed in some wells but it was not possible to do so in others. Thus many wells had to be abandoned. The farmers of Mehsana and adjoining districts in north Gujarat have no alternative but to dig more wells to keep their economy going. The State Government is alive to the danger of unrestricted withdrawals from ground water reservoirs, and is making a study of ground water behaviour in 400 wells spread all over the State. We were glad to note that this study is being done systematically and carefully. We would suggest that in districts where a marked fall in the water table has occurred, new tubewells should be sanctioned only after the study of the ground water table is completed.

4.42 We were glad to note that the State Government is proceeding apace with electrifying tubewells all over the State. Loans are being granted to the State Electricity Corporation, to enable it to expand the electrification programme. As electrification reduces the recurring cost of running a tubewell and enlarges its command, we would recommend that the electrification programme should be pursued vigorously.

4.43 One doubtful feature of irrigation from State tubewells is the practice of giving tubewell water to farmers in the order in which they apply for it. The practice is bound to create anomalies and would lead to the

waste of water. If, as may happen, the farmers who first apply for water, have their fields at the tail of distribution channels, not only would water be lost in transportation over long distances, but it will create the danger that farmers nearer to the well may cut the channels and resort to unauthorised irrigation. It would be desirable to introduce the normal practice of giving water by turns to groups of farmers situated along the channels in the command of the tubewell. We feel that the system of giving water only on the basis of the timing of applications should be discontinued, and the Warabandi system introduced.

4.44 We were glad to note in many places that, in order to minimise seepage and evaporation losses, water from tubewells was being distributed through concrete pipes instead of long open channels. In spite of the heavy initial costs of laying these pipes (about Rs. 740/- per hectare), we found that the farmers of Gujarat had accepted the practice because it is economical in the long run. The success of water distribution through pipes will be of interest to other States. We would recommend that the farmers should be encouraged to lay underground pipes to reduce seepage and evaporation losses.

Mahi Project

4.45 We were happy to note that the Agriculture Department which, in Gujarat, is responsible for the construction of field channels, is carrying out experiments in lining field channels. It was explained that where irrigators had not constructed the field channels, the Agriculture Department does it on their behalf, and recovers the cost from them. A welcome feature of the system is that the channels are made to reach every field within the command. Even though the per-hectare cost is high, being Rs. 173/- farmers appear to like the arrangement.

We noticed that under one of the outlets in the Mahi Command, the area proposed to be irrigated was 31 hectares for a discharge of 0.05 cumec which works out approximately to a duty of about 620 hectares per cumec. This appears to be very much on the low side, particularly when no perennials were being grown and the main crops using the water were cotton and tobacco. Such cases should be rationalised. At Simaliya village in Dakor taluka in the Mahi ayacut, we were shown field channels lined with precast concrete slabs. The cost of these channels works out to Rs. 865/- per hectare. It will be interesting to watch how successful these channels prove to be. We trust the engineers will keep a careful watch and overcome difficulties which may occur.

At the trial-cum-demonstration farm at Tasra, we were shown the results of various experiments carried out to assess the water requirements

of various crops. We were told that the experiments showed that bajri requires eight irrigations of a total depth of 0.73 m and that wheat required five irrigations, including one pre-sowing irrigation. Demonstrations were also being carried out in the farmers' fields.

Training programmes to educate the farmers and farm-women on improved agricultural practices were also in operation. One such course for farm women was in progress on the farm at the time of our visit.

The Panchmahals

4.46 At Nadiad, we met the farmers of Panchmahals district, who complained about the hardships suffered by farmers in the area for lack of adequate water. The district had been categorised as a backward district, and they urged that special consideration should be given to it. They made the point that, if the waters of the Panam river could be used to provide irrigation in the district, and a right bank canal from the Kadana dam could also be led into it, the district would be greatly benefited. They pressed that meanwhile check-dams should be constructed wherever possible. The possibility of drilling tubewells should also be examined. The State officials were of the view that the sub-soil conditions and the character of the underlying rock formations in Panchmahals was such that the construction of tubewells was doubtful. However, some investigations were continuing and if they succeed, trial tubewells would be drilled.

The Panchmahals being a backward area, generally inhabited by tribals, we recommend that the State Government should consider the possibility of using water from the Kadana Project for irrigation in this area. We learnt with a degree of concern, that the banana plantations were planned to be increased under the Kadana Project. It seems to us questionable that any water which could profitably be used to irrigate more areas in the Panchmahals should be used to extend banana cultivation within the Kadana project. We urge that this matter should be carefully reviewed by State Government.

Kakrapar Project

4.47 The State officials accepted that the development of the ayacut under the Kakrapar Project had been slow, the main reason being that the area received consistently heavy rainfall and, therefore, irrigation water was not being fully utilised. We were assured that, with the commissioning of the Ukai dam project, when the total irrigable area will rise to about 40,470 hectares, the position would greatly improve and the intensity of irrigation would rise to about 95%. It was expected that the cropping pattern would be as follows:

	(In thousand hectares)
1. Perennials, light and heavy	50.6
2. Rice	93.1
3. Cotton	60.7
4. Jowar	60.7
5. Wheat	50.6

As there is no system of localization in Gujarat and no control over cropping, we apprehend that difficulties may arise when, due to seepage of water, damage to crops like cotton and jowar may be caused in the kharif season. In the circumstances, we recommend the feasibility of adopting some system of localization, in order to prevent this damage.

The practice of constructing weirs to take advantage of the run-of-the-river is very popular, but the difficulties experienced in the Kakrapar area underline the necessity to ensure that, when an upstream dam is constructed, the time gap between the erection of a weir and the completion of the storage dam should be reduced to the minimum. The ayacut development can reach its optimum only when the storage is complete, and water made available for irrigation in both the rabi and kharif seasons.

Machhu Project

4.48 On our way from Gandhidham in Kutch to Rajkot in Saurashtra, we were able to see some of the irrigation works under the Machhu I Irrigation Project. This storage scheme has an irrigation potential of 8,900 hectares. We were informed by the Chief Engineer that, in the year 1968-69, a gross area of 9,766 hectares was actually irrigated. We were impressed by the keenness of farmers to utilize irrigation water effectively. They grow improved varieties of cotton as well as groundnut, lucerne and wheat. The water courses had been constructed by the farmers themselves. We were told that, after the introduction of irrigation, prices of land in the ayacut had jumped from Rs. 250/- to Rs. 3,700/- per hectare; and that with the rise of the water table, there had been a five-fold increase in the number of open wells in the area. These seemed to us to be welcome developments, but we would suggest that the field channels should be lined to economise water.

Cropping Pattern

4.49 A recent study on the likely agricultural development in the command area of the Kadana dam, has forecast that once water becomes available from this dam, 40 per cent to 50 per cent of the farmers in the ayacut will go in for cultivating bananas, hybrid bajri and high-yielding

varieties of paddy, wheat and hybrid cotton. The study shows that, in the rabi season, there is likely to be a marked shift from tobacco to wheat, and, in the summer season, to hybrid bajri. In view of the high yields obtainable from the hybrid and high-yielding varieties of cereal, we feel that the State Government should encourage the cultivation of such crops in the newly irrigated areas. This seems to us to be particularly called for as the State is highly deficit in foodgrains though only about half of the cultivable area is under food crops.

Wherever rainfall is high as, for example, in Kakrapar there would be no harm in encouraging the cultivation of high-yielding varieties of paddy in the kharif season. However, the cultivation of rabi paddy should be discouraged and other crops whose water requirements are lower should take its place. We have already remarked that Panchmahals district should be given priority in the supply of water to grow food crops, rather than to allow this water to be used for extending the cultivation of bananas. Broadly speaking, we would urge upon the State Government to adopt a policy of growing only light irrigated crops in scarcity areas and the only exception should be made in case of low-lying areas where rice cropping becomes inevitable.

Mehsana

4.50 We have already mentioned the precarious position of ground water in this scarcity district of north Gujarat, and have recommended that restriction should be placed on the extension of tubewell irrigation there. During our visit to the district, among the pressing problems brought to our notice, one related to the use of the Banas waters. The farmers of areas lower down in the Banas valley complained that, before the construction of the Dantiwada dam on the Banas, they used to get the benefit of the flood waters of this river to irrigate their fields, but after the construction of the dam they had, to a large extent, been prevented from raising good rabi crops through the use of inundation water. They voiced a strong protest against the proposed construction of the Sipu dam, on the ground that not only would it deprive them, completely, of the use of the residual inundation waters of the Banas, but that, by preventing the periodical leaching of salts in the areas adjoining the Little Rann of Kutch, the Sipu dam would encourage further encroachment by the Little Rann on cultivated lands adjoining it. They suggested that, instead of a storage dam, three or four small check-dams should be constructed on the river.

It is not our intention to suggest that in an area where water is scarce, any attempt to store it should be discouraged, but we feel that the prescriptive privileges and water needs of the farmers who made representations to us, should not be lost sight of. Perhaps a canal from the dam leading to

these areas would meet their needs. We also feel that the progressive encroachment of the Little Rann is a matter which needs to be thoroughly examined, and some means to restrict this encroachment should be devised.

Rajkot Reservoir

4.51 We visited the reservoir which supplies drinking water to the town of Rajkot, where successful efforts have been made to avoid evaporation losses by coating the water surface with a film of cetyl alcohol. We were told that the use of cetyl alcohol, has reduced evaporation losses by as much as 40 per cent. It costs Rs. 90/- to save a million gallons of water. The treatment has to be given daily because the wind velocity at the surface of the reservoir tends to blow the film to one side of the reservoir almost everyday. We were happy to note that efforts are being made to cope with the problem of evaporation losses, and record our appreciation of the Gujarat Government's initiative in this matter. It would be desirable that similar experiments be carried out in other parts of the country.

The Navagam Dam

4.52 We visited the site of the proposed Navagam Dam on the Narmada river, and were impressed by the thorough and intensive investigations which have been done of the foundations. We also inspected the laboratory of the Kavadia Colony where there is an excellent museum with maps and models, and visited the gauging site at Garudeswar. It has been possible, we were told, to measure discharges up to a flood of 50,970 cumecs the maximum flood in 1970 being 70,790 cumecs. It is a pity that the delay in the agreement to share the waters of the Narmada should have halted the progress of work.

CHAPTER V

HARYANA

Haryana came into being on 1.11.1966 after the reorganisation of the erstwhile State of Punjab. It is the third smallest State in the Indian Union, with an area of 43,867 sq. km. The Yamuna forms the border between Haryana and Uttar Pradesh. The Ghaggar, another large river in the State, is a non-perennial stream subject to flash floods and loses itself in the sand dunes of Rajasthan.

A major portion of the State is served by the Western Yamuna and the Bhakra Canal Systems and together, these systems irrigate about 1.4 million hectares. The Gurgaon Canal, another major work under construction, is intended to utilise the surplus waters of the Ravi, the Beas and the Yamuna.

Haryana's population of 9.97 millions (1971), is the fourth smallest in the country and constitutes 1.8 per cent of the total population of India. Nearly 82 per cent of the total population lives in villages and agriculture is their mainstay.

The principal crop of Haryana is wheat followed by bajra and gram. Other important crops are barley, jowar, rice, maize, sugarcane and cotton.

Physiography

5.2 In the north, Haryana is bounded by the Siwalik range, and in the east by the Yamuna. The Aravalli range, running south of Delhi through the Gurgaon and Alwar districts and on to the desert of Bikaner, forms the boundary to the south-west. To the west, the Ghaggar stream forms part of the boundary between Haryana and Punjab.

The State lies between the basins of the Indus and the Ganga, and is formed almost entirely of alluvium. Its north-eastern district of Ambala lies largely in the foothills of the Siwaliks. Karnal and Rohtak districts are in the plains to the south of the Aravalli range. Extensive sand dunes, several metres in height, run in a contiguous strip of desert, 7,770 sq. km. in area adjoining Rajasthan. There is a gradual rise from the plains towards the Sohna plateau and the Aravalli range.

The Haryana plain has an average elevation of 283 m above sea level.

Sand dunes occur in parts of Sirsa, Fatehbad, Hissar, Bhiwani, Dadri, Mahendragarh, Narnaul, Rewari and Jhajjar tehsils. The height of the Aravalli range varies considerably; the highest point being 518 m above sea level. The Morni hills with an elevation of 1,499 m in the Naraingarh tehsil of Ambala constitute the highest point in Haryana. The Pinjore gardens, a famous tourist spot, are at a height of 676 m above sea level.

The State can roughly be divided into two tracts, namely, the Ghaggar tract and Western Yamuna tract; the first forming almost 3/5th of the region. In the south, the Sahibi nadi rises in the Alwar series of the Aravalli hills and eventually falls into the Yamuna, crossing the Ghaggar and Rewari tehsils of the State.

Soils, Climate and Rainfall

5.3 The soil largely consists of alluvium containing sand, clay, silt and hard calcareous concentrations. In the southern region known as the Khadar, the alluvium consists of sand and some silt, deposited by rivers and small mountain-streams. Broadly, the State can be divided into five soil regions:

(i) Desert soils—These are found in parts of the Hissar, Mahendragarh and Gurgaon districts where the annual rainfall is less than 300 mm. These soils are deficient in nitrogen, phosphorus and potash.

(ii) Sierozen soils—These are found in parts of the Rohtak, Hissar, Gurgaon and Mahendragarh districts where the annual rainfall varies from 300-500 mm. Salinity and alkalinity are serious problems, particularly in irrigated areas. Erosion by wind is common. Almost all these soils are deficient in nitrogen, phosphorus and potassium.

(iii) Arid brown soils—These are found in parts of the Gurgaon, Karnal, Rohtak and Jind districts, where the annual rainfall varies from 500-650 mm. Salinity and alkalinity are serious problems. There are also problems of wind and water erosion. These soils are very deficient in nitrogen but contain phosphorus and potassium.

(iv) Tropical arid brown soils—These are found in the remaining parts of Karnal and in major parts of Ambala district where the annual rainfall ranges between 750-900 mm. Waterlogging, drainage, salinity and alkalinity are fairly serious problems. These soils are deficient in nitrogen, phosphorus and potassium.

(v) Reddish brown soils—These are found in parts of the Ambala district where the annual rainfall ranges between 1000-1500 mm. The erosion of soil due to run-off is a very serious problem. The soils are mildly acidic to neutral in reaction and deficient in nitrogen and phosphorus but contain potash, zinc and iron.

5.4 The climate of Haryana, over most of the year, is of a pronounced continental character i.e. very hot in summer and very cold in winter. The temperature in the months of May and June rises to 40°C. It drops to 2°C to 3°C in January. During the winter, the region remains under the influence of cool winds, with occasional cyclones which bring rain. The summer is characterized by great heat, desiccating hot winds, and occasional dust-storms, particularly in the sandy and water-scare tracts of Mahendragarh and Hissar.

5.5 The rainfall in the State is scanty and erratic. It is highest (about 2,160 mm) in the foot hills, and the lowest (250 to 380 mm) in the south. The rainfall is distributed between the monsoon rains from the middle of June to September, on which the autumn crop and spring sowing depend and the winter rains from December to February, which benefit the rabi crop. About 80 per cent of the total rainfall occurs in the period from July to September and this concentration of rainfall occasionally causes floods affecting large areas.

Land Use and Cropping Pattern

5.6 Table 5.1 gives the land utilisation statistics for the year 1968-69.

Table 5.1

Land Use Details—Haryana

Category	Area in thousand hectares	Percentage to the total area
1	2	3
Geographical area	4,422	—
Reporting area	4,400	100.0
Forests	92	2.1
Land not available for cultivation	483	11.0
Other uncultivated land excluding fallow land	122	2.8
Fallow land	430	9.7
Net area sown	3,273	74.4
Area sown more than once	781	17.7
Total cropped area	4,054	92.1
Net area irrigated	1,312	—
Net area irrigated as percentage of net area sown	—	40.1
Gross area irrigated	1,864	—
Gross area irrigated as percentage of gross cropped area	—	46.0

5.7 Table 5.2 below shows the area under principal crops for the years 1968-69 (provisional).

Table 5.2

Principal Crops—Haryana

Crop	Total cropped area in thousand hectares in 1968-69
1	2
Rice	229
Wheat	898
Jowar	208
Bajra	873
Maize	82
Barley	165
Gram	577
Total food grains	3,118
Sugarcane	161
Oilseeds	84
Cotton	212
All crops	4,054

Foodgrains occupy about 76 per cent of the total cropped area, of which wheat, occupies about 22 per cent. The area under wheat in the State is about 5.8 per cent of the total area under this crop in the country (1967-68 to 1969-70) and the production is 9.2 per cent of the total wheat production in the country. The State ranks fourth among the wheat producing States and second among the gram producing States (19.1 %)*.

The other important foodgrain crops are bajra, barley and jowar. Haryana's share of the total production of bajra and barley in the country is 8.9 and 7.7 per cent respectively.* It ranks fifth among the bajra producing and third among the barley producing States of the Indian Union.

Cotton and sugarcane are the major non-foodgrain crops. Haryana produces 6.6 per cent and 5.3 per cent of the country's cotton and sugarcane respectively ranking sixth among the States.*

Surface Water Resources

5.8 The principal river of the State is the Yamuna. We have described this river in Chapter XX dealing with Uttar Pradesh.

*All the figures relate to years 1967-68 to 1969-70.

The Eastern and Western Yamuna Canals take off from the Tajewala Headworks, below which the Yamuna forms part of the boundary between Haryana and Uttar Pradesh, where it enters the territory of Delhi. The Tons and the Giri are right bank tributaries of the Yamuna.

The Ghaggar with its tributaries, the Tangri, the Markanda, the Saraswati and the Chotanga, is a non-perennial flash river which peters out in the sands of the Rajasthan desert. The Dohan, Krishnawati, Sahibi and Lendoh are also smaller flash streams rising in the Aravalli to the south.

5.9 The discharge of the Yamuna is being observed at the Tajewala weir by the Dadupur Division of the Western Yamuna Canal, East Circle; of the Ghaggar and its tributaries in the hill reaches, by the Project Division of the Project and Design Circle; of the flow at the crossing of these channels with the Narwana Branch by the Pehova Division of the Ambala-Bhakra Canal Circle; and of the Ghaggar at the Ottu weir (the lowest gauging site) by the Sirsa Division of the Hissar-Bhakra Canal Circle. The discharges of the Dohan, Krishnawati and Sahibi streams in the south are being observed by the Rohtak and Haryana Divisions of the Western Yamuna Canal (West) Circle.

The observation of discharges at Tajewala on the Yamuna and of Gumthala on the Ghaggar have been carried out since 1879 and 1956 respectively. Regular observations on the Dohan, Krishnawati and Sahibi were started in 1964.

5.10 The preliminary assessment of the surface water resources of Haryana reveals the position described below:

The annual inflow of the Yamuna at Tajewala has varied from 13,679 m.cu.m. to 6,352 m.cu.m. and the mean annual inflow for the 25 years between 1921-22 and 1945-46 was 10,312 m.cu.m.

The average flow of the Ghaggar and its tributaries is of the order of 2,159 m.cu.m. This occurs mainly between June and September though in some years some inflow has been recorded in October.

From the discharge data of the Dohan Nadi for the years 1964 to 1968, it has been estimated that 6 cumecs of water would be available for about 43 days, in all, if the crest of the diversion weir is at RL 1018. In the case of the Krishnawati Nadi, with a capacity of 4.33 cumecs it has been found that it ran for 21 days in 1966, for 25 days in 1967 and for 30 days in 1968. The pond above the diversion weir on this river can supply water for approximately 5 days, which is too short a period to help crops to mature. Regular discharge observations on the Sahibi Nadi have been made at Jarthal only since 1964. Here a discharge of 14.86 cumecs would be available for 32 days on the average without storage and for 52 days on the average with storage.

Ground Water Resources

5.11 Ground water exploration in Haryana up to the end of the Third Five Year Plan was done by the Exploratory Tubewells Organisation (ETO) of the Government of India, now renamed Central Ground Water Board (CGWB). The CGWB drilled 48 exploratory bores out of which only 5 were successful. From March, 1968, part ground water exploration is also being done by the State Exploratory Cell. The CGWB does the work of exploration while the State Cell delineates the sweet-water boundaries, works out safe yields and evaluates the extent of the aquifers. Only a part of the State has been covered by these operations, and it will take at least 3-4 years to cover the whole State.

The utilisable annual ground water recharge in the State of Haryana is approximately 1,838 m.cu.m. (1.49 million acre feet)*. Nearly 81 per cent area of the State either has brackish ground water, or areas where the exploitation of ground water recharge is not possible.

Present Stage of the Development of Irrigation

5.12 The Western Yamuna Canal constructed in 1820 is the first major irrigation work of Haryana. Before the construction of this canal, the irrigation was done by wells. The canal first took off from the Yamuna near Hathnikund. There were no permanent headworks at the river and supplies depended on the level of water in the river. The remodelling of the canal was taken up in 1873, and between the years 1875 and 1879, a permanent weir across the river was constructed at Tajewala and low masonry dam at Dadupur, at the confluence of the Pathrala and Somb, torrents about 19.2 km below Tajewala was also put up. Nearly 50 years later, between 1940 and 1943, the canal was again extensively remodelled and extended, by putting up storage dams on the Sutlej and Beas, making available additional supplies of water. The canal system is again being remodelled to carry the enhanced supplies from the Ravi. The gross area irrigated annually at present is 0.544 million hectares.

The most important work taken up after Independence, is the Bhakra Nangal Project on the Sutlej. Other major projects comprise the remodelling of the Western Yamuna Canal, the Western Yamuna Canal Feeder, the Gurgaon Canal, the Beas Project Unit-I & Unit II across the river Beas and Link works to transport the Ravi-Beas waters into command of the Western Yamuna Canal. Table 5.3 below gives a list of projects costing more than Rs. ten million each, undertaken after 1951:

*Dr. Raghava Rao's paper at Symposium on Water Management.

Table 5.3

Projects Costing More Than Rs. 10.0 Million
Undertaken in Haryana After 1951

Project	Cost (Rs. million)
1	2
Bhakra Nangal (completed) (including Punjab)	1751.44
Raising and strengthening banks of channels (completed) (including Punjab)	11.49
Remodelling of the Western Yamuna Canal	95.00
Western Yamuna Canal Feeder	33.10
Rewari Lift Irrigation (from W.Y.C.)	16.00
Gurgaon Canal	83.60
Beas Project Unit I	29.96
Unit II	159.50
Link works to transport Ravi-Beas waters to W.Y.C. tract	270.22
Augmentation Tubewells in W.Y.C. tract—Stage-I (128 nos.)	11.11
Jui Canal (Lift Irrigation)	33.11
Loharu Lift Irrigation Scheme—Stage-I	43.10
Sohna Lift Irrigation Scheme	11.04

5.13 Some of these projects are described briefly in the following paragraphs.

Bhakra Nangal Project

The Bhakra Nangal Project is one of the largest and outstanding multipurpose projects in the world. It consists two fully integrated units, the 'Nangal' and the 'Bhakra Dam'.

The Bhakra Dam is a reinforced concrete structure of the straight gravity type, across the river Sutlej at the foot of the Siwalik hills in Himachal Pradesh. Its maximum height is 226 m and length 518 m. The dam was completed in 1963. About 13 km downstream is the Nangal

Barrage which feeds the Nangal Hydel Canal. The canal takes off a short distance upstream, on the left bank of the river. It is lined throughout its length of 64.4 km and is designed to carry a maximum discharge of 354 cumecs. That canal serves as a feeder for the Bhakra Canal System below Rupar, and for generating power at the power stations at Ganguwal and Kotla, which are 19.3 km and 28.9 km from the head of the channel respectively. A third power station is likely to be built later on the hydel channel.

The Bhakra Canal System has been planned to serve the arid and scarcity tracts of Punjab and Haryana and a part of the Bikaner district of Rajasthan.

It comprises the following schemes:

(i) The construction of the Bhakra Canals, fed by a 354 cumecs hydel channel.

(ii) The remodelling of the Rupar Headworks and the old Sirhind Canal to give the canal an additional discharge capacity of 99 cumecs.

(iii) The construction of the Bist Doab Canal, taking off on the right bank of the Sutlej at the Rupar Headworks, with a discharge of 39.6 cumecs.

The system utilises a discharge of about 509.7 cumecs and has a length of 1,110 km of main and branch canals and 3,379 km of distributary channels. The total area benefiting from the three schemes mentioned above, is nearly 4 million hectares out of which new areas cover about 2.4 million hectares. Work on the canal system was completed in 1954, though from 1952, a restricted supply was given from kharif irrigation.

Beas Project

The waters of the Sutlej, Beas and Ravi were allotted to India under the Indus Water Treaty. The Project on the Beas has been undertaken for harnessing the water and power resources of the river by means of storage and diversion works. The project which will benefit Haryana, Punjab and Rajasthan, consists of two parts, Unit No. I—Sutlej-Beas Link; and Unit No. II—The Pong Dam on the river Beas.

(i) Unit No. I (Sutlej-Beas Link): envisages a diversion dam at Pandoh in the Kulu valley, to transfer 4,589 m.cu.m. (3.72 MAF) of water of the Beas river to the Bhakra reservoir through tunnels and open conduits. This will obviate the danger of a fall in the level of the Bhakra reservoir and will provide canal irrigation to Gurgaon and other southern districts of the State. A natural fall of 305 m at Dehar will be utilised for the generation of power.

(ii) Unit No. II (Pong Dam) : envisages an earth-cum-gravel dam on

the Beas in Kangra district. The dam will be 100.6 m high and will release regulated supplies of water into the Rajasthan Canal and the Punjab Canal System emanating from the Harike Headworks. The water will also be utilised for the generation of power in a power house situated downstream of the Pong Dam.

Link Works to Transport Ravi-Beas Water to the Western Yamuna Canal System

Under the Indus Water Treaty, water was supplied to Pakistan from the Ravi and Beas for a transitional period which has since expired. The Haryana State has a share in the water of these two rivers. On completion of Unit I of the Beas Project, water from the Beas will be carried to the Gobindsagar lake, and thence to the Bhakra Nangal and Western Yamuna Canal Systems. Supplies of water are expected to become available in 1974. It is vital, therefore, for the carrier channels to transport these supplies from the Sutlej basin, and the W.Y.C. system to be completed simultaneously, so that the water can be utilised forthwith. A project for the construction of a link channel 196 km long with 199.32 cumecs capacity has been prepared at an estimated cost of Rs. 270 million. The proposed link channel will take off from a point about 32 km upstream of Rupar, and will run parallel to the Bhakra Main Line, the Narwana Branch and Narwana Branch-Karnal Link, up to its outfall in the Western Yamuna Canal System near Karnal. When completed, this link will provide more water to areas already commanded by the Bhakra Canal and the Western Yamuna Canal. It will also provide irrigation to new areas in the districts of Mahendragarh, Rohtak and Hissar.

Gurgaon Canal Project

The project envisages a canal 59.43 cumecs capacity, taking off from the Agra Canal near Okhla to extend irrigation to 0.13 million hectares, by flow as well as by lift, in the Gurgaon district of Haryana. This is a joint project with the Rajasthan State. The Gurgaon Canal will deliver 14.15 cumecs of flood water at Rajasthan's border with Haryana.

The major portion of the main canal and the distribution system have already been completed.

Western Yamuna Canal Remodelling Project

The scheme provides for the remodelling of the Western Yamuna Canal System which takes off from the Tajewala Headworks, to extend irrigation facilities to an additional area of 0.24 million hectares C.C.A. in the

districts of Karnal, Rohtak, Jind, Hissar and in Delhi State, besides increasing the water allowance and the intensity of irrigation. Perennial supplies from the Beas will become available on completion of the Beas Project.

Western Yamuna Canal Feeder Project

Under this project two links are to be constructed viz., (i) The Narwana Branch Karnal Link and (ii) The Barwala Link: The Narwana Branch Karnal Link connects the tail of the Narwana Branch of the Bhakra System with the Western Yamuna Canal System near Karnal. It is a lined channel 26 km in length and of 76.4 cumecs capacity and cost Rs. 20.34 million. It has already been completed and commissioned.

The Barwala Link is a lined channel 26 km in length, and of 48.1 cumecs capacity connecting the Bhakra Main Line with the Sirsa Branch near Narwana. It is estimated to cost Rs. 13.64 million. The major portion of the project has been completed. Through these links, the Ravi-Beas waters will be transported to various canal systems in the State.

Rewari Lift Irrigation Scheme

The scheme envisages the extension of lift irrigation to 55,650 hectares of Rewari and on adjoining area in the districts of Rohtak, Mahendragarh and Gurgaon by pumping which will be done in stages. It involves the construction of 257 km of new channels and the remodelling of the existing channels.

Augmentation Tubewells in Western Yamuna Canal Tract—Stage I

The project envisages the installation of 128 tubewells—each with a capacity of 0.06 cumecs along the Western Yamuna Canal from Dadupur and Munak. This scheme will bring additional supplies of water to 10,164 hectares thus increasing the intensity of irrigation in the areas commanded by the Yamuna Canal System.

Wells and Tubewells

Irrigation by open dug wells has long been practised in Haryana. The number of pucca wells in use in 1968 was 56,673. In addition, there were 608 State tubewells and 12,857 private tubewells, including filter points. The net area irrigated by these ground water sources in 1966-67 was 0.281 million hectares.

5.14 The net area irrigated from different sources in 1968-69 was as follows:

Table 5.4

Source-wise Irrigation in Haryana—1968-69

Source	Area irrigated (thousand hectares)
1	2
Canals	907
Tanks	2
Tubewells	76
Other wells	309
Other sources	18
Total:	1,312

The gross area irrigated was 1,864 thousand hectares. The salient features of irrigation works irrigating more than 4,000 hectares each, are given in Table 5.5.

Ayacut Development

5.15 Large areas of Haryana, as we have seen, are level plains and do not present any problem of land-levelling. Most of the level areas are, however, covered by the commands of the existing irrigation works. In some new areas to be irrigated, such as the commands of the Rewari Lift Canal, and the Gurgaon Canal, the land is uneven and dotted with sand dunes. These areas do present problems of land-levelling. In Haryana, there is enough of cattle power to do the levelling of gentle slopes, but some lands where the gradient is steep may need mechanised land levelling. At present, the responsibility of land-levelling rests on the farmer, but it is a matter for examination by the State Government whether any financial help and technical advice is needed by the farmer.

Another hurdle in the speedy utilisation of irrigation potential is the proper maintenance of water courses and the excavation and maintenance of field channels, all of which are the responsibility of farmers. The Haryana farmers are keen to benefit from irrigation, but they are lacking

Table 5.5

Salient Features of Projects Irrigating 4,000 Hectares and Above

S. No.	Name of project	Source of water/ Name of river	Storage/ Non-storage	Capital cost (Rs. million)	Year of completion	Type	Max. height (metres)	Length (metres)	Gross	Storage capacity (m.cu.m. Live)	Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)
1.	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Western Yamuna Canal (including extension schemes)	Yamuna	Non-Storage	57.74	1820 1892	Weir and canal system	—	—	—	—	106	961,000	544,000
2.	Dadri Irrigation	W.Y.C.	-do-	7.67	1956	Canal	—	—	—	—	8	—	Benefits included in No. 1.
3.	Bhakra-Nangal	Sutlej	Storage*	1751.44	1963	R.C.C. dam	226	518	—	10,361	354	11,87,000	830.000

*For both Punjab and Haryana.

Source: (1) Irrigation Statistics of India 1960-61, CW & PC—March, 1968.

(2) Note-Volume of Irrigation Chapter on Haryana, CW & PC—March, 1970.

(3) Replies to the Irrigation Commission's Questionnaire, Government of Haryana—April, 1970.

in cooperation to maintain water courses and field channels and to excavate field channels. We have dealt with the subjects of land-levelling and water courses and field channels in Chapter VII of Volume I of the Report and the State Government may examine the matter in the light of our observations there.

With the increased tempo of agricultural development, especially through the application of the new strategy of 'Intensive Cultivation', the training and education of farmers has assumed added importance. For deriving optimum benefits it is essential to link inputs with advanced technical know-how. With this objective, the programme for the training and education of farmers, in operation in the two districts of Rohtak and Gurgaon, is proposed to be extended so that by the end of the Fourth Plan, there will be eight Farmers Training Centres. The Agricultural Information Service for conveying the latest technical know-how to the farmers through publicity, leaflets, crop competitions etc., will continue to function.

Drought Affected Areas

5.16 In Haryana, the chronically drought affected areas measure 7,770 sq. km. They are located in a belt contiguous to Rajasthan in the Mahendragarh district, in the Jhajjar tehsil of Rohtak district, in the Bhiwani tehsil of Hissar district, and in the Rewari tehsil and the Sohna plateau of Gurgaon district.

The common characteristics of these areas are low and erratic rainfall, high wind velocity especially during the period from April to June, extreme variations of temperature coupled with a lack of vegetative cover, which causes soil erosion and the shifting of sand-dunes. Due to high temperature and low humidity during the summer, the rate of evaporation is extremely high. Sub-soil water is either scanty or brackish or both, which makes it unfit for human or plant consumption.

Being situated at the tail end of both the Bay of Bengal and the Arabian Sea currents of the monsoon, the area gets very little rain, which ranges generally between 25-30 cm. annually. There is practically no rain during May and June. The rainfall during December, January and February is generally scanty and erratic in its distribution. A large portion of the annual rain falls during the period July-September. Consequently, the 'kharif' crop is the main stay of the farmers and the 'rabi' harvest on unirrigated lands is a gamble on the rains.

The low rainfall, the lack of artificial irrigation facilities and the reduction of the fertility of land in drought affected areas, all combine to reduce the yield of crops, and the intensity of cropping. The poor return from farming leads to greater dependence on cattle breeding, which in some areas, has become the only gainful occupation for the local population.

The drought of 1966 caused a loss of 4.334 million quintals of foodgrains and in terms of money Rs. 254.3 million. As much as 0.61 million hectares was left unsown.

The population affected was 0.79 million. Similarly, the drought of 1968 caused a loss of 7 million quintals of foodgrains and in terms of money Rs. 403 million. Besides, the State Government spend Rs. 9.45 million on relief.

So far, the broad approach in the development plans for chronically drought affected areas had been to lay emphasis on—

(i) increase in the supply of power and of drinking water;
(ii) minor irrigation schemes;
(iii) investigation of ground water resources;
(iv) soil and water conservation work and dry farming practices;
(v) afforestation and conservation of natural pastures;
(vi) investigation of mineral resources;
(vii) diversification of agriculture; and
(viii) spread of small scale industry.

In 1969, the Haryana State Government decided to take up irrigation schemes for this area. The first of these was the Jui Lift Irrigation Scheme intended to cover 33,185 hectares of the drought affected area of Hissar district. Work on this project was started in November, 1969 and 72 km of channels were completed by July, 1970. Three pumps with an aggregate lift of over 15 m worked successfully from July to October, 1970. The Loharu Lift Irrigation Scheme intended to cover over 97,451 hectares of the drought affected area of Mahendragarh district, was prepared in July, 1970. Work on it has been authorised and will be executed in two stages. Stage I, costing Rs. 43.1 million will cover a gross area of 52,625 hectares, involving the construction of 175 km of new lined channels, and the remodelling of about 24 km of unlined channels. A supply of about 11.3 cumecs would be needed for this Stage I, increasing to over 24.06 cumecs when Stage II is completed. When completed, Stage I is expected to produce additional foodgrains worth Rs. 33.5 million per annum, against a financial investment of about Rs. 43.1. million.

We would draw the attention of the State Government to our recommendations with regard to irrigation development in drought affected areas, particularly to the possibilities of irrigating areas in the Mahendragarh and Hissar districts through the Yamuna Pumping Storage and Ground Water Recharge Scheme.

Future Development of Irrigation

5.17 A list of important projects which have been investigated by the State Government is given in Table 5.6.

There is, in our opinion, considerable scope for exploiting the water of the Yamuna basin. Two storage sites have been located, one at Kishau on the Tons in Uttar Pradesh and the other at Chandni on the Giri in Himachal Pradesh.

Table 5.6

Future Projects of Haryana

Project	Source of supply	Area proposed to be irrigated annually (hectares)
1	2	3
Sohna Lift Irrigation Scheme (Stage-II & III)	Yamuna & Ravi-Beas waters	78,700
Nahar-Salawas Lift Scheme	Ravi-Beas	6,300
Dadri Lift Irrigation Scheme	-do-	15,300
Providing irrigation to Rewari area from Sahibi	Sahibi river	8,500
Utilisation of waters of Dohan	Dohan Nadi	5,000
Utilisation of waters of Krishnawati	Krishnawati Nadi	3,200
Raising capacity of Bibipur Lake	Saraswati & Markanda tributaries of river Ghaggar	No direct irrigation
Installation of 30 direct irrigation tubewells in Naraingarh area	..	3,600
Installation of 170 direct irrigation tubewells in Naraingarh area	..	20,600
Installation of 25 direct irrigation tubewells in Indri area	..	3,500
Installation of 25 direct irrigation tube-wells in Mahindragarh area	..	3,500
Installation of 100 direct irrigation tubewells along river Ghaggar	..	14,000
Installation of 25 direct irrigation tubewells in Jind area	..	3,500
Installation of 25 direct irrigation tubewells in Tohana area	..	3,500
Installation of 15 direct irrigation tubewells in Pehowa area	..	1,800
Installation of 10 direct irrigation tubewells in Kalwar area	..	1,200
Installation of 100 tubewells augmentation along Delhi Parallel Branch	..	8,800

Taking into account all types of irrigation works, the future potential for irrigation development in Haryana comes to 1.95 million hectares. With the development of this potential the total irrigation in the State will come to 3.81 million hectares. This works out to about 94 per cent of irrigation, to gross cropped area.

Table 5.7 below briefly indicates the ultimate picture of irrigation development in Haryana.

Table 5.7

Total Irrigation Potential of Haryana

(*million hectares*)

Item	Major & medium projects	Minor irrigation works	Total
1	2	3	4
Area irrigated in 1969	1.29	0.57	1.86
Additional irrigated area on completion of projects under execution	1.49	0.25	1.74
New projects*	0.18	0.03	0.21
Total:	2.96	0.85	3.81

*Only those investigated so far.
Kishau and Tons are excluded.

Floods, Waterlogging and Drainage

5.18 The problem of floods in Haryana is acute as there are no natural outlets for excess water during the rains. There have been several heavy floods, particularly since 1947. Breaches in Diversion Drain No. 8 and the intensity of the flood in the outfall drain at Dhassa have even affected territory in Delhi. Table 5.8 gives (i) the extent of the areas flooded (ii) the damage to crops and (iii) the money distributed as relief to flood victims during the last twelve years.

The factors mainly responsible for heavy flooding are (a) an inadequate drainage system, (b) inadequate water-ways under roads, railways and irrigation channels, (c) spills from the rivers, (d) absence of dams and check-dams on river catchments and (e) denudation of the hills. The remedy lies, therefore, first in preventing spills from the rivers and secondly, in providing an adequate surface drainage system and properly-sized water-ways under roads, railways, and irrigation channels.

Table 5.8

Flood Damages and Relief Measures in Haryana

Year	Total cropped area damaged (hectares)	Value of crops damaged (Rs. million)	Amount spent on relief measures *(Rs. million)
1	2	3	4
1955	133,413	21.55	16.26
1956	41,909	9.02	0.25
1957	2,559	0.54	0.03
1958	294,913	123.11	3.08
1959	16,360	2.78	0.33
1960	254,087	50.17	17.32
1961	196,148	40.30	5.76
1962	202,551	48.26	5.77
1963	163,505	48.63	15.71
1964	277,661	115.09	7.89
1965	28,613	3.58	N.A.
1966	170,535	44.10	0.87
1967	199,255	172.78	1.39

*The figures up to 1964 are based on 40 per cent of the amount distributed in Punjab before reorganisation.

To protect areas against flooding 1,641 km of drains and 219 km of flood embankments have been built, which will provide protection against normal as well as heavy floods. Additional embankments are being constructed. A Master Plan for the whole of the State envisaging an outlay of Rs. 800 million has been formulated. The State has been divided into two tracts, namely the Ghaggar tract and the Yamuna tract. The Master Plan envisages the construction of 4,988 km of surface drains and 274 km of flood embankments.

5.19 The evil of waterlogging has also appeared in a number of places in Haryana. The district of Karnal, the tehsils of Hansi, and Gohana and the Safidon area of the tehsil of Jind have large waterlogged areas, aggregating about 0.20 million hectares. To check the rise of the water table along the Western Yamuna Canal, 256 tubewells were installed along the Main Line and the Main Branch. Recently 128 more tubewells have been installed along these channels. A scheme for installing 100 tube wells along the Delhi Branch has been investigated. To relieve waterlogging along the Hansi Branch near Hansi, the Hansi Anti-Waterlogging Scheme has been implemented. It comprises seepage drains on both sides of the canal with pumps at suitable locations to lift seepage water into the canal. Besides, pumps have been installed at the villages of Ladhaut, Dhamar, Kiloi and Rani Khera to dewater depressions which get filled up during the monsoons.

We would draw the attention of the State Government to our recommendations in Chapter XIII of Volume I where we have dealt with waterlogging and drainage, particularly to the sections on the inspection and maintenance of drains.

The Irrigation Department has estimated that about 0.14 million hectares are affected by salinity/alkalinity in the irrigated areas. Soil surveys of the Bhakra areas, conducted before the introduction of irrigation from the Bhakra Canal, indicated salinity/alkalinity has affected about 0.34 million hectares. This area is in addition to the damaged areas mentioned earlier. It may be stated here that salts are normally met with in the soil profile at some depth over the entire State. Visual observation (thur girdavari) made by the patwaris indicates that salinity/alkalinity exists in about 0.81 million hectares outside the command of irrigation channels. Schemes for the reclamation of saline/alkaline areas are under preparation.

Water Rates

5.20 The assessment of revenue from canals, tubewells and other irrigation works is governed by Sections 33-39 and 44 of the Northern India Canal and Drainage Act, 1873, as amended from time to time. Water rates recoverable for crops are included in the schedule of Occupiers' rates of the said Act. A copy of the Schedule applicable to the Bhakra Canal and Western Yamuna Canal is reproduced in Appendix 5.1.

In the case of tubewells, the water rate is charged on the basis of the units of electricity consumed. The present rate is 25 paise per unit, but it is being revised to 35 paise per unit.

In addition, the owner's rate is charged on the irrigated areas. Owner's rate or water advantage-rate, or 'nahri parta' is charged on canal irrigated

areas. It is levied in terms of Sections 37-39 of the Northern India Canal and Drainage Act. The following scale has been prescribed:

(i) Perennial Irrigation Rs. 3.00 per acre matured
(ii) Restricted perennial Rs. 2.00 per acre matured
(iii) Non-perennial irrigation Rs. 1.50 per acre matured

If water from any irrigation work is lifted by an irrigator at his cost, the above rates are reduced to half. When crops are irrigated from drains or escape channel waters, the rates prescribed for non-perennial irrigation are charged.

Betterment Levy

5.21 Betterment levy is leviable in terms of the Punjab Betterment and Acreage Act, 1953, according to which the betterment fee should be equal to the cost of the unproductive part of the project, provided that it does not exceed half the value of the land benefited by the project. According to law, it should be recovered on the basis of C.C.A., but at present it is being levied on the basis of the matured area. The levy can be paid in a lump sum or in 30 half-yearly instalments or by the surrender of land in lieu of full or part payment.

The Punjab Government decided to recover betterment charges in advance, subject to adjustment of sums collected on the finalization of the schedules of betterment charges on the Bhakra Nangal Project and the Western Yamuna Canal Remodelling Project at rates not exceeding Rs. 23 per matured acre. The rates generally applied are given below, although the Punjab Government had the power to reduce, and had actually reduced these by 50% for the kharif of 1960:

	Rate per matured hectare (acre)	
	Gravity flow irrigation hectare (acre)	Lift irrigation maintained and operated by land owners hectare (acre)
	Rs. p.	Rs. p.
1. Areas which will ultimately receive perennial irrigation	24.71 (10.00)	12.36 (5.00)
2. Areas which will ultimately receive non-perennial irrigation	12.36 (5.00)	6.18 (2.00)
3. Areas which will ultimately receive restricted perennial irrigation	18.53 (7.50)	9.27 (3.75)

	Rate per matured hectare (acre)			
	Gravity flow irrigation hectare (acre)		Lift irrigation maintained and operated by land owners hectare (acre)	
	Rs. p.		Rs. p.	
4. Areas where water allowance is ultimately to be increased	6.18	(2.50)	3.09	(1.25)
5. Areas where non-perennial irrigation is ultimately to be converted into perennial irrigation	12.36	(5.00)	6.18	(2.50)
6. Areas where non-perennial irrigation is ultimately to be converted into restricted perennial irrigation	6.18	(2.50)	3.09	(1.25)

The betterment levy collected from 1958-59 to 1966-67 on different projects is shown below:

	Rs. million
(i) Bhakra Nangal Project	66.34 (up to 31.10.66)
(ii) W.Y.C. Remodelling	18.23
(iii) Dadri Channel	2.28
(iv) Rewari Lift Channel	0.07
Total	86.92

CHAPTER VI

HIMACHAL PRADESH

Himachal Pradesh which was raised from a Union Territory to the status of a full-fledged State on the 25th January, 1971, is the eighteenth State of the Indian Union. With an area of 55,673 sq. km., it is the fifth smallest State in the country. As presently constituted, it comprises (i) the erstwhile Princely States known formerly as the Punjab Hill States, which were consolidated into a single unit in 1948; and (ii) Hill areas of the erstwhile Punjab State which were integrated with Himachal, consequent upon the reorganisation of Punjab on the 1st November 1966.

6.2 The rivers Yamuna, Sutlej, Beas, Ravi and Chenab, pass through the hills of the State and provide a large hydro-power potential. The Sutlej receives the Beas at Harike above Ferozepur before joining the Chenab at Madwala in Pakistan. The Ravi passes into Pakistan about 26 km below Amritsar. It joins the Chenab a little lower down at Trimmu in Pakistan. The Chenab enters Pakistan near Akhnur in Jammu & Kashmir and joins the Sutlej at Madwala near Panjnad, where the combined waters of the five eastern rivers of the Indus basin namely the Sutlej, the Beas, the Ravi, the Chenab, and the Jhelum, ultimately fall into the Indus which drains into the Arabian Sea.

6.3 Population-wise Himachal Pradesh is the second smallest State in the country (Nagaland being the smallest). More than 93 per cent of its population of 3.42 millions (1971) reside in villages where the main occupation is agriculture with paddy, maize, wheat, potato and fruits as the main crops.

Physiography

6.4 The State can be divided into three physical zones: (i) Outer Himalayas, (ii) Inner Himalayas and (iii) Alpine Pastures. The Outer Himalayan Zone is below 3,048 m. in altitude and has a rainfall between 150 and 180 cm. The Inner Himalayan zone lies above 3,048 m. and experiences a rainfall

of 75 to 100 cm. The Alpine Pastures comprise areas which are under snow for five to six months in the year. The inhabitants of this zone migrate to lower altitudes during the winter.

Soils

6.5 The six districts of the old Himachal viz., Kinnaur, Mahasu, Mandi, Chamba, Sirmur and Bilaspur, constitute five soil zones. In the Paonta tehsil of Sirmur, Mandi, the Bhattiyat tehsil of Chamba, the Kunihar area of Mahasu and the greater portion of Bilaspur low hill type soils, suitable for growing wheat, maize, sugarcane, ginger, paddy and citrus fruits are found. The middle-hill type soils, found in Nahan and Pachhad, parts of Chamba and Churah tehsils, the Jogindernagar and Sarkaghat tehsils of Mandi and Rampur, the Kasampti, Solan and Kothkai tehsils of Mahasu, are suitable for growing potatoes, stone-fruits, wheat and maize. The high-hill soils, which are good for seed potatoes and temperate fruits, are found in the Theog, Jubbal, Chopal and Rohru tehsils of Mahasu, the Rainka tehsil of Sirmur, the Chachiot and Karsog tehsils of Mandi and parts of Bharmour and Churah sub-tehsils and around Dalhousie in Chamba. Mountain soils not suitable for agriculture are found in parts of Bharmour, Churah and Chamba tehsils of Chamba district and Karsog and Chachiot tehsils of Mandi. China and Pangi sub-tehsils get heavy snow. They have a dry hill soil and are ideally suited for fruit orchards.

Simla district has brown hill soils over sand stones and shales. Kangra district has large areas of these soils, and some areas covering sub-montane soils (Podsolic). Kulu district has a predominance of sub-montane soils (Podsolic), but also some brown hill soils over sand stones and shales. Parts of it are covered by glaciers and perpetual snow. The districts of Lahaul and Spiti have sub-montane soils (Podsolic). Many areas are covered with glaciers and are perpetually snow bound.

Climate

6.6 The climate of the State is governed by altitude and rainfall. The snow covered mountain slopes are rugged and inhospitable and cannot be cultivated. The lower slopes are terraced wherever they can support crops. They get some snow in the winter and plenty of rain during the monsoons. Food-grains, potatoes and fruits are grown. The Outer Himalayan zone is at a lower altitude, where the land is undulating and cultivation is done on terraces. Most of the important towns of the State are situated in this zone.

Rainfall

6.7 The annual rainfall in the State ranges from 283 cm. in Kangra

district to 45 cm. in Lahaul and Spiti districts. Dharamsala in Kangra district has, however, the highest rainfall of 320 cm. The bulk of the rain falls during the months of July, August, and September, though some is received in other months.

Land Use and Cropping Pattern

6.8 Table 6.1 gives the land utilisation statistics for Himachal Pradesh (post re-organisation) for the year 1967-68 (the latest year for which these are available):

Table 6.1

Land Use Pattern

Category	Area in thousand hectares	Percentage to the total area
1	2	3
1. Geographical area	5,568	..
2. Reporting area	5,568	100.0
3. Forests	2,678	48.1
4. Barren and unculturable land	355	6.4
5. Land put to non-agricultural uses	174	3.1
6. Culturable waste	150	2.7
7. Permanent pastures and grazing lands	1,561	28.0
8. Land under misc. tree crops and groves not included in net area sown	40	0.7
9. Current fallows	60	1.1
10. Other fallow lands	3	0.1
11. Net area sown	547	9.8
12. Area sown more than once	352	6.3
13. Total cropped area	899	16.1
14. Net area irrigated	90	1.6
15. Cropped area irrigated	152	2.7
16. Percentage of net area irrigated to net area sown		16.4
17. Percentage of gross irrigated area to gross area sown		16.9

6.9 During 1967-68 (the latest year for which data is available) the following principal crops were grown on the area indicated against each:

Table 6.2

Principal Crops Grown

Crop	Area in thousand hectares in 1967-68
1	2
Rice	100
Maize	243
Ragi or marua	14
Wheat	316
Barley	45
Gram	23
Potatoes	18
Sugarcane	4
Oilseeds	27
All crops	899

The main cereal crops in Himachal Pradesh are rice, wheat, maize and barley. Other food crops include gram and other pulses. The main commercial crops of the State are potatoes, ginger, and sugarcane. Oilseeds such as sesamum, rape & mustard and linseed as well as cotton, tea and tobacco are also grown.

Himachal Pradesh has a great tradition of prosperous horticulture. The physical features and climate of the State facilitate the cultivation of a variety of fruits. Quality apples from Kotgarh in Mahasu district are famous. Efforts are also being made to popularise citrus fruit orchards in the Paonta valley of Sirmur district.

Surface Water Resources

6.10 The rivers Sutlej (Shutudri), Beas (Vipasha), Ravi, Chenab (Chandrabhaga) and the Yamuna flow through this State. The Sutlej rises in the plateau of Tibet at a height of about 4,570 m. from the famous lake Manasarowar. It flows through mountain ranges rising to a height of 6,100 m. through Himachal Pradesh and enters the Punjab in Hoshiarpur district. The river emerges from the Siwalik hills at the Bhakra gorge and flows as a narrow deep stream through low hills for about 16 km., before it widens. It receives the Beas at Harike above Ferozepur, and joins the Chenab at Madwala in Pakistan.

The Beas rises in the Pir Panjal range near the Rohtang pass at a height of about 3,960 m. A number of its tributaries cross the Dhauladhar range

at Larji, and join the Beas just below Mandi. In its first 120 km., the river's fall averages 23.2 m. per km. but after Larji, the gradient rapidly decreases, and in the valleys of the outer Himalayas, it is hardly more than 1.9 m. per km. From its source to its confluence with the Sutlej at Harike in Ferozepur district, the river has a length of about 467 km. The Ravi rises in the Bara Banghal area in Chamba district and drains the southern slopes of the Dhauladhar. After crossing the Siwaliks, it enters the Punjab plains at Madhopur. From its source to the Indo-Pakistan border, the river has a length of about 370 km. The river passes into Pakistan at about 26 km below Amritsar.

In the Himalayan region, two streams called the Chandra and the Bhaga, rising on opposite sides of the Baralacha pass 4,891 m., unite at Tandi to form the Chenab river. It flows in a north-westerly direction for over 161 km through the trough formed by the Himalayas and the Pir Panjal range. It then enters the Doda district of Kashmir, and after flowing for about 322 km. between steep mountains passes into Pakistan below Akhnur. From the point where the Chandra and the Bhaga meet to the Indo-Pakistan border the distance measures 378 km.

The Giri is an important right bank tributary of the Yamuna, and flows through the State.

6.11 The Irrigation Circle has recently started discharge observations on various 'khads'.* The data has not yet been compiled.

6.12 The surface water resources of the major rivers have been assessed by the Department of Multi-purpose Projects and Power. The data is available for the period 1943 to 1962. The average annual flow of the principal rivers for these years has been estimated at 16,503 m.cu.m. (13.38 MAF).

Ground Water

6.13 Only reconnaissance reports showing the depth of the water-table in the various regions have been prepared by the Geological Survey of India (GSI) and the State Geological Department. The GSI has been requested by the State Government to undertake detailed ground water surveys. There are very few areas in Himachal Pradesh where open percolation wells can be successfully sunk. Wells have been dug primarily for drinking purposes, but they can provide irrigation for small plots of land especially in the low hill zone extending over the Paonta tehsil of Sirmur, the Balh area of Mandi, the Bhatiat tehsil of Chamba, and Bilaspur district, where the underground resources appear to be adequate. The Department

*Khad—a ravine (with or without a stream flowing through it).

of Agriculture has begun sinking wells in the valleys and an area of 800 hectares has been brought under irrigation. There are also possibilities for sinking tubewells in the Paonta valley. As a result of exploratory drilling, three tubewells were energised and maintained by the Public Works Department (PWD) in 1965, in Dhaula Kuan, Majra and Paonta Sahib, respectively. Additional tubewells are proposed to be drilled in this valley. The Irrigation Circle has now completed 15 tubewells in Una tehsil.

Present Stage of the Development of Irrigation

6.14 Cultivation in Himachal Pradesh is generally done on terraced fields on hill slopes and in the valleys. For this reason, even when there are adequate perennial supplies of water, irrigation on a large scale is not possible. Farmers construct small contour channels, which are fed from local springs or hill streams. Channels with a perennial supply of water are called 'kuhls' and those which get only seasonal supplies are called 'katuls'. 'Katuls' outnumber 'kuhls'. Water from these channels is taken from adjoining khads.

'Kuhls' and 'katuls' have been the main source of irrigation in the territory from times immemorial. However, these channels are usually temporary and are damaged by floods and land-slides during the rains. They are an unreliable source of irrigation. No other type of irrigation is practised on any appreciable scale, though small patches in a few places in the Paonta valley of the Sirmur district are irrigated by dug wells. In a few places in the valley, tubewells have also been sunk.

6.15 The State Government has, generally at the request of the beneficiaries undertaken the construction of new 'kuhls' and of strengthening, renovating and lining of existing 'kuhls'. By the end of the Third Five Year Plan, the State PWD had completed 186 schemes covering an aggregate culturable catchment area of 15,770 hectares at an estimated cost of Rs. 14.82 million. The achievements in the Punjab hill areas now part of Himachal Pradesh, however, are not known. Three small and recently constructed canal systems, one near Bilaspur and two in the Paonta valley, are described below.

6.16 *Chandpur Canal:* This canal is situated about 19 km. west of Bilaspur. It was originally sanctioned for construction in 1959 at an estimated cost of Rs. 0.27 million for the first stage to benefit the villages of Jalhal and Deslin in the tehsil and district of Bilaspur. The canal takes off from the Ali Khad where a weir and head regulator have been constructed for diverting a perennial supply of 0.5 cumec into the canal. In the first stage 8 km. of the canal has been constructed and it has been partially

lined. The canal is designed to irrigate an area of 576 hectares. Of this 154 hectares was to be irrigated in the first stage, between 1959 and 1962. The actual expenditure incurred is stated to be Rs. 0.37 million.

6.17 *The Bata Majra Canal:* This canal with a maximum discharge of 0.42 cumec runs in the Paonta valley to the north-west of village Matak Majra in the district of Sirmur. It takes off from the Batar river whose waters are first utilised for rotating 'gharats' (grinding mills). After passing through the mills, the water of the river is diverted to feed the head regulator of the canal. The total cost of the scheme was Rs. 0.30 million and it commands a culturable area of 486 hectares.

6.18 *The Rampur Giri Canal:* This canal runs through more or less flat country at a distance of about 8 km. to the north-east of Paonta Sahib in Sirmur district. It is 10 km. in length and takes off from the right bank of the Giri river which forms the boundary between Himachal Pradesh and Uttar Pradesh. The diversion bundh is formed of boulder crates, and is washed away during the monsoon. The bund has to be re-erected every year. The head regulator has an opening of 1.22 m $\times$ 1.83 m and the canal which has a CCA of 1,044 hectares is designed to run with a head discharge of 0.85 cumec. Completed in 1958 during the Second Plan the scheme costs Rs. 0.74 million.

6.19 With the support of the Indo-German Agricultural Project, in Mandi district, the vegetable growers lift water by electric pumps from the Suketi khad. Favourable conditions for this type of lift irrigation exist in many places in Himachal Pradesh, particularly in the valleys. The use of electric pumps for lifting water should be encouraged. Since the State is covered by a network of electric power lines, lift irrigation through pumps can be extended considerably.

The experts attached to the Indo-German Agricultural Project, are also experimenting with sprinkler irrigation, using mobile sprinkler sets. Water is pumped from a stream and distributed through pipes laid in the farmer's fields. Sprinklers are connected to outlets and the pressure is sufficient to sprinkle water from each sprout to an area within a radius of about 15.2 m. The scheme to introduce sprinkler irrigation in farmers' fields covers 520 hectares in Mandi district and 80 hectares in Sirmur district.

6.20 In the year 1967-68, out of a total gross irrigated area of 152,000 hectares, the area under food crops was 141,000 hectares or 92.8 per cent. Normally, with an ample and well-distributed rainfall, good paddy and wheat crops can be raised without irrigation. In drought years, however, yields are poor.

6.21 The net area irrigated from different sources in 1967-68 are as follows:

Table 6.3

Source-wise Irrigation

(Thousand hectares)

Source	Area irrigated
1	2
Government canals	a
Private canals	—
Tanks	a
Wells	1
Other sources	89
Total :	90

Note: (a) less than 500 hectares.

Ayacut Development

6.22 With no major or medium irrigation project in the State, ayacut development has not posed a problem. However, in the case of minor irrigation, some difficulties have been experienced in developing irrigation in new projects.

Farmers in the State are not irrigation-minded. They are not accustomed to taking water from canals according to the requirements of the crops and have a tendency to wait for the rains. They go on waiting in the hope that rains will obviate the necessity to use canal water and that they will not be called upon to pay water charges.

Farmers are responsible for the construction of field channels but they do not usually build these channels. Since no provision is made in the estimates of minor irrigation schemes, for field channels, the development of irrigation is hindered. Irrigation is done from field to field. There is no system under which field channels can be constructed departmentally, when farmers cannot or will not construct them.

We would draw the attention of the State Government to our recommendations in Chapter VII of Volume I of our Report, where we have stressed the necessity for field channels in any system of progressive irrigation. The principles which we have enunciated apply not only to the ayacuts of major and medium schemes, but also to the areas commanded by minor irrigation works.

We would also suggest that farmers be assisted to undertake land-levelling and land-terracing so that the best use can be made of irrigation water from minor projects. We have discussed this matter at length in Chapter VII of Volume I of our Report.

We found that in the matter of land-levelling and land-terracing, no financial assistance is given to the farmers, although the Irrigation Circle of the Engineering Department gives them advice with regard to such matter. It is, perhaps, for these reasons, that there has been a shortfall in full development of irrigated areas.

We were given to understand that, in some cases, water is not available over the whole command of minor projects because the farmers in the head-reaches take more than their fair share of water and the tail-end farmers have to do without it. We would recommend that the distribution of water should be strictly regulated so that no individual farmer gets any unfair advantage. Shortages are also due to canal seepage which reduces the amount of water available for irrigation. We were given to understand that canals are being lined in reaches where there is heavy seepage.

Future Development of Irrigation

6.23 *Paonta Valley Irrigation Scheme:* This project envisages diversion of water for the generation of hydro-electric power from the river Giri through tunnels out-falling into the Bata river. The tail race of the power house will feed the lower bank canal in the first stage of the project. The canal will irrigate about 5,200 hectares land of the Paonta valley at a cost of Rs. 10.7 million.

In the second stage, the right bank canal will be taken off by constructing a barrage across the river Bata. However we were given to understand that the irrigation part of this scheme has not so far been approved by the Technical Advisory Committee of the Planning Commission.

6.24 According to the State Government, in the Bahl valley an area of about 7285 hectares can be irrigated if about 2.8 cumecs of water is made available by the Beas Construction Board from the diversion channel carrying the waters of the Beas to the Sutlej.

6.25 The Bhakra and Nangal reservoirs situated inside the Himachal Pradesh can, according to the Himachal Pradesh Government, irrigate an area of about 8,094 hectares adjacent to the Nangal reservoir. The State Government are anxious that this should be permitted. The case deserves examination on merits.

6.26 The scope for future development of irrigation consists mainly of

minor irrigation works. For the following types of schemes a sum of Rs. 60 million has been allocated in the Fourth Plan:

1. Lift irrigation schemes to utilise waters of rivers and streams in valleys;
2. Lift irrigation schemes using water from percolation wells in beds of khads and choes;
3. Tubewell schemes;
4. Flow irrigation by kuhls; and
5. Installation of pumping sets on private wells.

It is anticipated that this sum will enable to cover irrigation of 24,282 hectares. This figure includes new areas as also areas now being irrigated whose supplies will be assured.

Floods, Waterlogging and Drainage

6.27 Though there are occasional floods, the floods are not a major problem in the State. After the integration of the hill areas of the erstwhile Punjab State with Himachal Pradesh, the flood control schemes of the Kangra district were transferred to the latter. During the year 1967-68 a number of proposals to protect lands suffering from erosion due to floods were taken up for investigation.

In the Fourth Plan a sum of Rs. 20 million has been provided for the investigation of the following flood control schemes:

1. Flood control work on the Markanda in Sirmur district;
2. Flood control works on the Bata Nadi;
3. Flood control works in the Bahl valley;
4. Flood control works in the Kulu valley; and
5. Reclamation of land from Rey to Kudubela in Kangra district.

6.28 There are a few waterlogged areas in Himachal Pradesh. So far no record of the water-table in these areas has been maintained. Steps are now being taken to deal with the problem of waterlogging.

Financial Aspects, Water Rates and Betterment Levy

6.29 *Water Rates:* Water rates are being charged only for the areas of Punjab merged with Himachal Pradesh according to the old Punjab rules. We were told that there was no provision for the recovery of water rates under the Minor Canals Act, 1968. The Act was being amended to levy water rates throughout the Province. The question of increasing water rates in the area where they are recoverable is also under consideration of the Government.

6.30 *Betterment Levy:* No betterment levy is being charged nor it is proposed to be charged.

Tours, Inspections and Observations

6.31 We toured Himachal Pradesh for three days from 24th to 26th October, 1971. From Chandigarh we proceeded, by car, to Bilaspur, Sundernagar and halted at Mandi on the 24th night. Next day we left Mandi early in the morning and reached Simla in the evening, seeing enroute certain tubewell irrigated areas. On the 26th October, we had a meeting with Dr. Y. S. Parmar, the Chief Minister of Himachal Pradesh and his ministers and senior officials. Earlier, we had an official discussion with the Financial Commissioner and other senior officers.

6.32 On our way from Bilaspur to Mandi we saw a lift irrigation scheme, in which 0.04 cumec of water is lifted to a height of 100 m. We were told that a number of such schemes are in operation in different parts of the State. We were also told that no irrigation charges are being levied at present. During our discussions with the Chief Minister, the latter expressed the view that such lift irrigation schemes should be built and operated by the farmers themselves on a co-operative basis. The State Government should give necessary loans and advances to the cultivators and also make available technical know-how. In this way the cost of maintenance and operation would be borne by the cultivators themselves and the State would not have to incur any losses. This is a good suggestion and we commend it for implementation.

6.33 We were also informed that Himachal Pradesh has not been permitted to lift waters from the Beas-Sutlej link canal for irrigating some small areas through which the canal passes. It appears that Punjab and Haryana Governments have not agreed to allow Himachal Pradesh to take even 5.66 cumecs out of the link canal.

We were also informed that though the Bhakra lake is situated in Himachal Pradesh and has submerged good cultivated areas, Himachal Pradesh is not permitted to lift water from the lake for irrigation except in some small quantities and that too on payment on cusec-day basis.

6.34 On the 25th morning we inspected the Sprinkler Irrigation Demonstration Project in Bahl valley of Mandi district, extending over an area of 162 hectares under the Indo-German Cooperation Programme. The water for the sprinkler system is tapped from three tubewells. We were told that irrigation for wheat is being given once in 10 days and a charge of Rs. 7/- per acre per irrigation is being levied. The lifting of water by tubewells has also helped to raise ground water level in this area.

6.35 We were also informed that the Geological Survey of India has

made some reconnaissance surveys for ground water and have selected a few areas in Sirmur, Mandi, Simla and Kangra districts for further exploitation. The State Government has also a proposal to provide irrigation from the Giri Hydro-electric Project. River Giri is a tributary of the Yamuna.

The Chief Minister mentioned that the State had ample resources for creating hydro-power potential and if the State Government is assisted in a big way by the Centre to exploit this hydro-power potential and take electricity to every corner of the State, it would improve the economy of the State. If cheap electricity replaces the fire wood for household purpose the cutting of trees would stop. The hydro-power would enable the State Government to put up a number of lift irrigation schemes, particularly to irrigate orchards for which the State is eminently suited.

6.36 Himachal Pradesh may not have much scope for developing irrigation, but the State deserves special attention for soil conservation. We are afraid that if proper attention is not given to soil conservation works, the massive Bhakra and Beas reservoirs may silt up much earlier than what was envisaged at the stage of project formulation. There is urgent necessity that the critical areas which contribute heavy silt-load to these reservoirs should be identified soon. In executing the soil conservation works, the States which benefit from the Bhakra and Beas reservoirs should fully share financial and other responsibilities.

6.37 We also feel that the Chief Minister's proposal for exploiting the hydro-power potential should receive early attention.

CHAPTER VII

JAMMU & KASHMIR

In this Chapter, we shall be dealing with the State of Jammu & Kashmir, excluding areas under the illegal occupation of China and Pakistan, as we could neither visit those areas nor get details of development in irrigation there.

The State of Jammu & Kashmir is a land-locked region in the extreme western sector of the Himalayas. It has an area of 222,236 sq. km., of which 83,808 sq. km. are under the illegal occupation of Pakistan and 41,500 sq. km. under the illegal occupation of China. The western boundary of the State is formed by Pakistan, the northern boundary by Afghanistan and China, the eastern boundary by Tibet and the southern boundary by the States of Himachal Pradesh and Punjab.

It is one of the most thinly populated States in India, and according to the 1971 census, had a population of 4.62 millions. Of this population, nearly 3.8 millions live in villages. Agriculture is the most important occupation, absorbing 67 per cent of the total working population.

Apart from the mountainous tracts of the Karakorams, the Pir Panjal and the Great Himalayan ranges, the State falls into three natural physical divisions, namely, the Jammu region, the Ladakh plateau and the Valley of Kashmir.

Rivers and Their Tributaries

7.2 The main rivers draining the State are the Indus, Jhelum and Chenab, with their tributaries. The Indus which is one of the world's great rivers, rises to the north of the Mansarovar lake in Tibet at an elevation of 5,182 m. It enters Kashmir at an elevation of 4,206 m. flowing over alluvium flats, and skirting Leh at an elevation of 3,200 m. It is joined by the Zaskar river near the ancient trade route through the Karakoram pass. Still flowing northwards, but bearing west, the river passes Skardu and the Haramosh peak. It then turns sharply southwest passing below the Hattu Pir and enters Pakistan.

The Jhelum rises at Vering in Kashmir and has several tributaries. It enters Pakistan near Muzaffarabad.

The Chenab, which is formed of two streams, the Chandra and the Bhaga, rises near the Baralachha pass in the Lahul district of Himachal Pradesh. The Chandra flows through the Lahul valley and the Bhaga through the Spiti. They combine at the bottom of the Lahul valley and the combined stream, known as the Chandrabhaga, flows through the Pangi valley and enters Kashmir at an elevation of 1,828 m. The river flows through precipitous gorges for about 290 km and then through the foothills of the Himalayas for another 40 km to Akhnur in Jammu district, whereafter it is joined by the Tawi, and enters Pakistan.

7.3 The principal rivers are perennial and snow-fed, but there are wide variations in their flows in different periods of the year. They carry the maximum flows during the rainy season, from July to September, and the minimum during the winter months. These rivers gather the major part of their flows from the mountain and hill ranges through which they pass, and their flows are at the highest as the rivers emerge from the foothills into the plains. Thereafter little surface flows is added by the run-off from the relatively large but arid part of their catchments. On the contrary, percolation and evaporation losses are heavy as the rivers flow through the plains.

The Indus flows are at their lowest from mid-December to mid-February, after which the river begins to rise. The period of maximum flood discharge is from mid-July to mid-August.

The Jhelum and the Chenab carry the lowest discharges from mid-November to mid-January, but the maximum flood discharge is usually in July.

The average annual flows of the Indus and other rivers at their rim stations, i.e. the uppermost gauging stations on each river, generally near the point where they debouch from the hills into the plains, are as follows:

Table 7.1

Annual Flows of Rivers of Jammu & Kashmir

(m.cu.m.)

River	Mean annual flow		
	Rabi	Kharif	Total
1	2	3	4
Indus (including Kabul river)	16,035	94,361	100,396
Jhelum	5,551	22,326	27,877
Chenab	4,564	24,423	28,987

The use of the waters of the Indus and other rivers flowing through Jammu & Kashmir is governed by the Indus Water Treaty which was signed in 1960 between India and Pakistan. According to the Treaty, the waters of the Indus, the Jhelum and the Chenab, and their tributaries, have been given to Pakistan. However, India can draw a specified quantity of water from the Chenab for agricultural use in the Ranbir and Pratap canals. The amounts to be drawn in various periods during the year have been detailed in the Treaty. India is also permitted to make withdrawals from the Indus and the Jhelum up to the limits prescribed in the Treaty. Not much use is being, or can be, made of Indus waters because of the character of the country through which the river passes in Kashmir, but good use is being made of the permissible amounts of water from the Jhelum and Chenab.

Land Use and Cropping Pattern

7.4 Agriculture is the most important economic activity in the State. Table 7.2 shows the land-utilisation statistics in the Jammu & Kashmir State during 1966-67 (the latest year for which the figures are available):

Table 7.2

Land Use Details—Jammu & Kashmir

Classification	Area (in thousand hectares)	Percentage to the reporting area
1	2	3
Geographical area	22,224	—
Reporting area	4,526*	100.0
Forests	2,769	61.1
Area not available for cultivation		
(a) Area put to non-agricultural uses	288	6.4
(b) Barren and unculturable land	260	5.7
(c) Total	548	12.1
Other un-cultivated land excluding fallow land		
(a) Permanent pastures and other grazing lands	127	2.8
(b) Land under misc. tree crops and groves not included in net area sown	121	2.7
(c) Culturable waste land	152	3.4
(d) Total	400	8.9

Table 7.2—contd.

Classification	Area (in thousand hectares)	Percentage to the reporting area
1	2	3
Fallow land		
(a) Fallow lands other than current fallows	16	0.4
(b) Current fallows	114	2.5
(c) Total	130	2.9
Net area sown	679	15.0
Total cropped area	815	..
Area sown more than once	136	3.0
Net irrigated area	284	18.0
Gross irrigated area	316	70.0
Percentage of net irrigated area to net cultivated area	..	41.8
Percentage of gross irrigated area to gross cultivated area	..	38.8

*Excludes data in respect of area under illegal occupation of China and Pakistan.
Source: E & S Directorate, Union Ministry of Food and Agriculture.

7.5 The cropping pattern in Jammu & Kashmir is predominantly made up of food crops, which accounts for nearly 90 per cent of the total cropped area in the State, as compared to 75 per cent for the country as a whole.

Table 7.3 shows the areas under different important crops during 1966-67:

Table 7.3

Areas under Different Crops—Jammu & Kashmir

Crops	Area (in thousand hectares)	Percentage to total cropped area
1	2	3
Principal cereals		
Rice	224	27.5
Wheat	160	19.6
Maize	241	29.6
Barley	17	2.1
Total principal cereals	642	78.8

Table 7.3—contd.

Crops	Area (in thousand hectares)	Percentage to total cropped area
1	2	3
Secondary cereals like		
Jowar, bajra, smaller millets and other cereals	35	4.3
Total cereals	677	83.1
Pulses		
Gram	2	0.2
Other pulses	50	6.1
Total pulses	52	6.3
Total food-grains	729	89.4
Other food crops	25	3.1
Total food crops	754	92.5
Cotton	1	0.1
Tobacco	1	0.1
Other non-food crops	59	7.3
Total non-food crops	61	7.5
Total cropped area	815	100.0

Among foodgrains, the main crops are rice (27.5%), wheat (19.6%) and maize (29.6%), which account for 76.7 per cent of the total cropped area, the balance of 12.7% being shared by inferior cereals and millets (6.4%), and pulses (6.1%). The only commercial crops of any significance grown in the State are oilseeds (5%) and apples (all fruits 1%).

The three natural physical divisions of the State, namely the Kashmir Valley, the Jammu region and the Ladakh Plateau have so little in common with each other that we shall deal, in the succeeding paragraphs of this Chapter, with each division separately instead of following the general pattern of other chapters of this volume.

The Kashmir Valley

7.6 The Kashmir Valley is the heart of the State, the most picturesque and the most heavily populated. Geologically speaking, it is a structural basin which, in past ages, was once the bed of a great lake. According to ancient legends and popular traditions, this vast lake was called 'Sati Saras' or the Lake of Sati. As legend has it, the Sage Kashyapa drained the

lake by cutting an outlet for it through the mountains at the north-western end of the valley.

Stretching for 150 km. from south-east to north-west, at an average elevation of about 1700 m. and an average width of 80 km., the valley is encircled by mountains. In the south, separating it from the Jammu region and the plains of India and Pakistan, is the Pir Panjal range through which the main passes are: The Banihal Pass 2,957 m., the Pir Panjal Pass 3,475 m. and the Golab Garh Pass 3,810 m. In the north looms the Great Himalayan range. The Pir Panjal Pass has been the most frequented route to Kashmir. The White Huns entcred Kashmir through it and the Mughals took the imperial road over this route into Kashmir. It was through the Pir Panjal Pass also, that the traveller Bernier, who visited the valley in the train of Aurangzeb, crossed into Kashmir.

More than half the area comprising the valley is composed of Karewas, which are low, flat plateaus consisting of stratified deposits of fine silt, clays, sand and gravel. These karewas or lacusrtine deposits, are geological formations of the Ice Age and overlie the terminal moraines of the first glaciation. They extend all the way from Shopyan to Baramula.

The important districts of the Valley are Srinagar, which contains the capital town of the same name, Anant Nag and Baramula. The well-known Dal and Wular lakes, as well as the tourist resorts of Srinagar, Gulmarg and Pahalgam lie in the Valley.

Cropping Pattern

7.7 A serious handicap in the full utilisation of cultivable land is the fact that the Valley lies under snow for three to four months in the winter when no cultivation is possible. Rice is the main crop during kharif. It is harvested in October. Thereafter, there is really no time left to sow a rabi crop which could germinate before the onset of winter. Only a rabi crop sown in September could germinate before the first snows. This crop would begin to grow after the melting of the snows in March and be harvested in June.

Through a series of research experiments, it has been found practicable to reap a short-duration early paddy crop and have enough time to sow a dwarf variety of wheat. In 1966-67, a second rabi crop of wheat, Larma Raju and Sonora 64, was raised. Sown after reaping the rice crop, it germinated before the snows and matured the following spring. Within a couple of years the local adaptations of Mexican wheat, Sonalika and Safed Larma, were sown over an area of about 12,000 acres. This practice of double cropping remains to be extended. Researches made hold out promise of the possibility of raising a second crop of barley, fodder, sugar-beat and peas.

7.8 The Kashmir Valley is reputed for growing temperate and subtropical zone fruits, apples, apricots, pears, peaches, plums, cherries, walnuts, almonds, etc. Both the fruit-bearing capacity and the area under fruit orchards have undergone great improvement, especially after the creation of the Department of Horticulture. We were told that the climate and soil of the karewas is eminently suited for raising orchards, provided arrangements for irrigation supplies are made. Indeed, the existence of the ruins of old irrigation works on some karewas go to show that those karewas were at one time put under crops or trees. As the water-requirements of orchards are low and the cost of lifting water is high, it would be worthwhile to explore the possibility of raising fruit orchards on the karewas by lifting irrigation waters.

The Problem of the Jhelum

7.9 The Vale of Kashmir is really the valley of the Jhelum and the Jhelum river or the Vitasta, as it is known from ancient times, is both the pride and the scourge of the valley. The Jhelum rises at Verinag in Kashmir and flows in a north-westerly direction for a length of 113 km. to the Wular lake. After emerging from the lake, it flows for another 27 km. before it cuts through the mountain at Khadanyar in a deep gorge.

Above Srinagar, the tributaries of the Jhelum are the Lidder, the Veshau, the Rambiara, the Wankaran and the Arapal. After flowing through Srinagar in a series of loops, the river is joined below the city by the Dudhganga and Sindh. Below the Wular lake, it is joined by the Ningle, the Pohru, the Vijh and a number of hill torrents.

The river has been navigable from ancient times and formed one of the most important means of communication through the valley. It is for this reason that all the great cities of Kashmir whether Hindu, Mughal, Afghan or Kashmiri, are all situated on its banks. The river is navigable from Khannabal through the valley till it joins the Wular.

From the earliest times, one of the problems of the Kashmir valley has been to control the flood waters of the Jhelum and to drain the valley after the floods. Since the river is an alluvial stream flowing through embankments, it frequently overtops these embankments when in flood. The flood waters carry considerable quantities of sand and silt and the bed of the river has been silting up for centuries. The problems of regulating the river and draining the flood waters had to be faced by Kashmiri rulers from the earliest times. In the reign of King Avantivarman (855 to 883 AD), the King's engineer Suyya, carried out a scheme of drainage in the valley, extending to the gorge at Khadanyar. He changed the entire course of the Jhelum from its confluence with the Sindh to its entry into the Wular lake.

The Jhelum floods pose a menace to Srinagar and protecting the city

from floods had become a pre-occupation of the Kashmir rulers through the centuries. It is because of the necessity to protect the city that the problem of the Jhelum is so intractable. If the levees were to be raised and strengthened so that no spill takes place above Srinagar, it might well spell the destruction of the city. In fact the spill into the valley acts as a safety valve to save Srinagar, from periodic inundations.

The floods of 1893 turned the valley into a vast lake and caused immense damage. Urgent steps were taken, therefore, to mitigate the evil and by 1903 a flood-spill channel was completed for diverting a part of the flood discharge from above Srinagar, passing it through low depressions and and discharging it back into the river some kilometres below the city.

The course of the Jhelum above the Wular has not changed its pattern for many decades. Because of the sluggish flow of the river in these reaches, there has been no marked change in its course. However, during the last twenty years, the bed of the river above Srinagar has risen appreciably, in places from one to two metres. Below Srinagar also, in certain reaches, the bed has risen by two metres. Both above and below Srinagar, there are valuable paddy lands and construction of a proper drainage would not only preserve these lands but result in the reclamation of more than 2,500 sq. km. of the swampy numbals.

The flood waters also inundate the marginal cultivated fields of the Wular lake.

The measures so far adopted to control the Jhelum floods above Srinagar consisted largely of the construction of bunds or embankments on both sides of the river. These bunds have, however, never been able to protect the valley against periodic inundations. They were either themselves breached by the river, or deliberately cut to allow the flood waters to escape from the main channel. In the 1928 floods, the river carried 2,265 cumecs at Sangam. The capacity of the Jhelum through Srinagar was estimated to be 906 cumecs. In 1950 the discharge passing through the city was estimated to be between 991 and 1,133 cumecs.

It is thus clear that any measures to protect the valley above the city would endanger the city itself, and what is obviously required is a combination of several flood control measures instead of the single system of raising embankments.

Among the measures recommended to control the floods in the Valley and to improve the drainage, are:

(i) Strengthening and re-aligning the bunds without raising them;

(ii) Improving the river channel by making cut-offs, etc;

(iii) The provision of a supplementary channel or flood way from Dogripura to Wular, and the improvement of the outfall channel by diverting the Ningle and the sediments of the Pohru river into the Wular lake; and

(iv) Stabilising the torrents below Baramula and clearing debris from the bed of the outfall channel.

If these measures are implemented, not only will the low-lying 'numbals', jheels and marshy lands be filled up by the silt brought down by the supplementary channel from Dogripura, but the Wular lake itself will be completely silted up by the detritus and silt deposited in it by the Pohru river, the Ningle nalah and other affluents. These new areas would then be available for cultivation.

Experts who have studied the problem of the Jhelum floods have recommended an increase in the discharge capacity of the existing flood spill channel. They have also suggested that the channel should be given a new head higher up the river, and that it should discharge direct into the Wular, instead of discharging back into the river. Should the Wular be allowed to be silted up or should it exist as a flood absorption reservoir, is a matter on which a decision has yet to be taken. It is also a disputed matter whether the cultivation on the Wular lake banks should be protected by the building of dykes.

By 1957, action on the basis of plans drawn up between 1950-1955 was taken, embankments along the Jhelum were strengthened, drainage channels and flood gates were constructed in the valley, and the capacity of the spillway channel was raised to enable it carry 481 cumecs from Patshah Bagh to Wular. Marginal bunds along low-lying pockets were also completed.

The Master Plan drawn up in 1958 envisaged a programme in three phases, at a cost of Rs. 220 million. Phase I comprised works on the Jhelum and its tributaries up to Srinagar, Phase II from Srinagar to the Wular, and Phase III from Wular to Khadanyar. The 1959 floods, the worst ever recorded, caused extensive damage in the valley and led to a rethinking on the subject. It was decided to concentrate attention on improving the capacity of the outfall channel beyond the Wular, which had a limited capacity of 1,011 cumecs at R.L. 5,186 (the highest level recorded so far) in the Wular lake. The proposal as accepted by the Jammu & Kashmir Flood Control Board aimed to raise the discharge capacity from 623 cumecs to 1,133 cumecs up to the confluence of the Jhelum with the Pohru, and up to 1,274 cumecs beyond Pohru for a lake level of R.L. 5,180. Work on the scheme began in 1960, and is likely to be completed in 1973 or 1974.

During the Third Plan, a sum of Rs. 85.0 million had been provided for flood control. But only Rs. 55.0 million were actually spent. The main cause of the shortfall was that foreign exchange for the import of machinery to execute the scheme was not forthcoming. Work on the outfall channel was, therefore, delayed. In the three years 1966-67 to 1968-69, a sum of Rs. 31.7 million has been spent. In the Fourth Plan, the following outlays have been sanctioned:

Continuing schemes	Rs. 62.54 million
New schemes	Rs. 5.00 million
Total	Rs. 67.54 million

Ground Water

7.10 The valley fill is composed of the Pleistocene Karewa formations, partly overlain by the recent alluvium of the Jhelum. The nature, extent and thickness of these alluvial sediments afford favourable conditions for the development of ground water. Numerous natural springs occur as a result of the effluent seepage of ground water on the fringes of the alluvial tract towards the encircling mountain ranges. These springs have sufficient discharge to be reckoned as potential sources of water for local needs. Near-surface ground water, particularly in the Jhelum alluvium occurs within three metres from the surface. In the vicinity of Srinagar, successful tubewells have recently been constructed within a depth of 150 m., yielding potable water of the order of 91,000 litres per hour. The studies so far carried out in the Kashmir valley warrant further systematic surface and sub-surface exploration, for the appraisal of the ground water resources of the valley.

In the valley, the most notable feature of the irrigation system is the high proportion of irrigation by zamindari kuhls which take off from rivers, nallahs and springs. Kuhls have been a feature of irrigation in the valley from the very earliest times. According to the earliest traditions recorded by Kalhana, they played a very great role, and the Suvarnmankalya Kuhl, which was erected by King Suvarna, still brings water to a great part of what was his domain, and is of great antiquity. King Lalitaditya (724-761 A.D.) is credited with having supplied irrigation facilities to villages near the modern Sakadar, by the erection of water-wheels which lifted water from the Jhelum. Under King Avantivarman, his engineer Suyya regulated the course of a large number of the tributaries of the Jhelum and channelled water for irrigation purposes through kuhls, each village being allotted whatever water was necessary for its crops.

At the beginning of the First Five Year Plan (1951), kuhls provided irrigation to an area of 0.16 million hectares compared to Government canals which provided irrigation to only 10,522 hectares.

As we have stated earlier, irrigation in the valley is predominantly under kuhls, which were constructed, owned and maintained by the local zamindars. After landlordism was abolished in 1951, the maintenance of kuhls was neglected and they fell into disrepair. This led to a waste of water and to a loss of command. Furthermore, due to a lack of control on the off-

take points, the kuhls became a great menace to agricultural lands during floods. The State Government has drawn up a programme under the minor irrigation scheme for arresting the deterioration and renovation of kuhls. The total number of kuhls involved in the programme is 2,046. The programme envisages the taking over of all kuhls with a command of 1,012 hectares or more, for renovation and restoration. The programme of renovation and restoration generally comprises:

(1) The construction of head regulators;
(2) The realignment and regulating of reaches where the slope is excessive;
(3) The provision of cross drainage works; and
(4) The strengthening of banks.

A provision of Rs. 18.58 million has been made for this work. The State Government has also decided that it will not take over zamindari kuhls irrigating less than 200 hectares (except in isolated areas) and the cultivators will be assisted in maintaining these kuhls.

The criterion laid down by the State Government for taking over certain classes of kuhls for repair and maintenance is good enough for normal condition. But a group of kuhls commanding less than 1,012 hectares in the aggregate stand in absolute need of repairs. Unless that is immediately done, they may be destroyed. This points to the need of modifying the criterion. We are of opinion that the State Government should undertake a programme of repairing all seriously damaged kuhls, may be that the larger ones are given a priority.

Waterlogging

7.11 The Kashmir Valley is covered by a large number of swamps or 'numbals', and waterlogged areas. These are most evident in the Sonawari area. Attempts have been made from ancient times to reclaim these areas by building levees and embankments. While the level of these low-lying areas has remained unaltered, the levels of the surrounding rivers and lakes have steadily risen which has intensified the problem of waterlogging.

The problem of waterlogging has been tackled rather effectively by installing batteries of de-watering pumps and dewatering-cum-irrigation stations. This has led to the reclamation of a sizeable area and firming up of the existing irrigation by using the pumped out water.

Irrigation Development

7.12 There has been considerable activity in the irrigation sector in the Valley during the Plan periods. Table 7.4 shows irrigation in the valley during the three Plans source-wise.

Table 7.4

Sourcewise Irrigation—Kashmir Valley

(Thousand hectares)

Year	Govt. canals	Private canals	Wells	Others	Total
1	2	3	4	5	6
1950-51	10	157	3	9	179
1955-56	13	172	2	5	193
1960-61	24	159	2	2	187
1964-65	30	172	2	3	207
1968-69*	62	213	2	7	284

*Relates to the whole of Jammu & Kashmir.

Table 7.5 shows the canal systems which existed in the Kashmir Valley Prior to 1951:

Table 7.5

Canal Systems in Kashmir Valley prior to 1951

Name of Project	Cost (Rs. million)	Benefits as per project design (thousand hectares)	Irrigation in 1954-55 (hectares)
1	2	3	4
Martand Canal (1905)	0.79	3.75	3,248
Dadi Canal (1936)	0.66	0.94	1,932
Zaingir Canal (1931)	1.66	4.94	4,354
Mandi Canal (1936)	0.14	3.22	1,885
Lol Kuhl Canal (1903)	0.21	0.56	1,662

Source: CW&PC—Note Volume of the Irrigation Chapter Jammu & Kashmir State, March, 1970.

Betterment Levy

7.13 In 1963 the Government had passed orders for the collection of a betterment levy on land under irrigation by kuhls @ 25 paise per Kanal (about Rs. 2/- per acre).

Water Rates

7.14 Water rates charged as abiana for both flow and lift are given below:

1. First Class (Paddy)	Rs. 5.28 per acre
2. Second Class (Maize, vegetable, alsi)	Rs. 2.64 per acre
3. Jallar or Jatla	Rs. 1.36 per acre
4. Abi Awal or Abi Doam lands for all types of crops (stabilised area)	Rs. 2.00 per acre
5. Wad Watter	Rs. 0.96 per acre
6. Rooni	Rs. 0.48 per acre
7. Lift Irrigation (wet crops)	Rs. 16.00 per acre

The Jammu Region

7.15 The Jammu Province consists of the districts of Jammu, Udhampur, Kathua, Doda and Poonch. Most of this area is heavily forested. About 46 per cent of the area of the Province is under forests, more than half in Doda and Udhampur districts, and 40 per cent in Kathua and Jammu districts. Poonch district, with 24 per cent of area under forests, is the least forested.

The south-west plains, locally known as Kandi, extend in a strip, 8 to 24 km. wide, along the India-Pakistan border, between the Ravi and the Chenab rivers, and comprise parts of Jammu and Kathua districts.

Soils

7.16 Soils in the Jammu region are deficient in organic matter and in nitrogen. In the plains, they have formed from the alluvium of the Ravi, Tawi and Chenab. They are deep, and vary in texture from loam to silt loam. In the whole of Udhampur district and in the hill areas of Bani and Basuli, the soils are shallow, and their texture varies from loam to clay loam. In the mountainous region of Doda and Poonch, the soils are shallow and vary in texture from clay to clay loam.

Climate

7.17 Temperatures in the sub-montane and mountainous tracts of Jammu, are high in the summer and low in the winter. The average rainfall in Jammu district is about 114 cm; Poonch receives more than 160 cm. per annum. The heaviest rainfall occurs in the months of July, August and September over the whole of the Jammu region.

Because irrigation facilities in Jammu Province are poor and the cropping

pattern inferior, the agricultural productivity is generally low. Poonch is the least productive of the districts, and the cropping pattern there is dominated by wheat and maize, with a low per hectare yield. Although Jammu has a fairly large double-cropped area, the advantage is largely offset by the poor cropping pattern and the low yields.

Cropping Pattern

7.18 Over the State as a whole, the increase in inputs and changes in the cropping pattern from 1951-52 to 1962-63 have increased the overall output of agriculture by 49 per cent. The increase was highest in the Jammu Province, i.e. 90 per cent, compared to 31 per cent in the Kashmir Valley. A substantial contributory factor to the comparatively high growth in Jammu, was the substantial increase in the double-cropped area. The percentage of the double-cropped area to the net sown area increased, during the period, from 8.3 per cent to 50 per cent in Jammu and Kathua districts and from 0.8 per cent to 32 per cent in the Doda, Poonch and Udhampur districts. The main reason for this increase appears to be the pressure of population, which compelled the inhabitants to take to more intensive cultivation.

Soil Erosion and Soil Conservation

7.19 Soil erosion is the bug-bear of agriculture in Jammu Province. The problem is compounded, because the Forest Department has not taken over huge areas of scrub jungle, which are heavily over-grazed, and liable to extensive gully and sheet erosion.

Of the 0.1 million hectares shown as current fallows in the State, the largest proportion lies in Jammu Province. It is expected that under the increasing pressure of population, the areas shown as fallow will gradually come under the plough.

The Government has drawn up a modest programme of soil conservation in the Fourth Plan. However, a more thorough survey is necessary to ensure that whatever money is available is expended in the worst affected areas. The Government will have to teach cultivators how to check erosion, in addition to the programmes it may undertake direct. It is estimated that nearly one-third of the agricultural land of the Province would be covered by the soil conservation programme by the end of the Fourth Plan. The estimated cost per hectare for soil conservation would be about five hundred rupees.

Irrigation

7.20 The three Plan periods have witnessed considerable activity in the

irrigation sector, particularly in the extension of the area under Government canals. Table 7.6 shows the extent of irrigation in the Province at the beginning of each Plan:

Table 7.6

Sourcewise Irrigation—Jammu Region

(Thousand hectares)

Year	Govt. canals	Private canals	Wells	Others	Total
1	2	3	4	5	6
1950-51	27	34	..	5	66
1955-56	42	34	..	5	81
1960-61	38	19	3	11	71
1964-65	35	25	Negligible	4	64

Source : 'Basic Statistics (1967-68)', by Government of Jammu & Kashmir.

In 1964-65, about 43 per cent of the net cultivated area was under irrigation in the State. The percentage of irrigation in Jammu was only 20 as against 62.5 in the Kashmir valley. Of the total irrigated area, the largest proportion was under Government canals.

In the Jammu Province, the State Government has taken up the remodelling of the Ranbir Canal System, which is the oldest canal in the State. It was built in 1905 and was initially designed to irrigate 14,164 hectares. Now, it provides irrigation to 52,608 hectares. It has become necessary to remodel the system in order to stabilise the existing command of 52,608 hectares and provide additional irrigation to 2,428 hectares.

Two of the major perennial rivers of northern India, namely, the Ravi and the Chenab, and their tributaries flow through the rich land in Jammu Province. But the utilisation of the Chenab waters is controlled by the terms of the Indus Water Treaty. The withdrawals of water for the Ranbir and Partap canals are prescribed under Clause 3 of the Annexure to the Treaty. Over and above this, under Clause 4 of Annexure C, not more than 40,468 hectares (100,000 acres) can be irrigated from the Chenab in Jammu Province. The share of Jammu and Kashmir in the Ravi waters is limited to 1,048 m.cu.m.

The Ravi Tawi Lift Irrigation Scheme has been formulated to irrigate a compact area between the Ravi, and the Tawi. The boundaries of this area are the lower Siwaliks on the east and the Indo-Pakistan border on the west. When the scheme is completed, all the supplies of the Tawi, Ujh and Ravi available to the Jammu & Kashmir State, will have been utilised. Phase I

of the Scheme, which comprises the Tawi Lift Irrigation Scheme, is already in progress.

The Government also proposes to take up a lift irrigation scheme from the Manawar Tawi, for irrigating 6,880 hectares in the Chamb Niabat, and on the Pargoal island which is situated in the Chenab river itself.

Once all these schemes have been completed and the water utilised to the permissible extent, the possibilities of large scale irrigation in Jammu Province would have been practically exhausted.

Table 7.7 shows the details of the canal systems which existed in the Jammu area prior to 1951:

Table 7.7

Canal Systems—Jammu Region (prior to 1957)

Name of Project	Cost (Rs. million)	Benefits as per project design (thousand hectares)	Irrigation in 1954-55 (hectares)
1	2	3	4
Ranbir Canal	4.86	54.41	46,081
Pratap Canal (1904)	0.60	6.47	1,231
Ujh Canal (1923)	0.31	6.88	1,393
Basantpur Canal (1917)	0.36	3.01	959
Upper Jhelum Canal	0.08	0.26	N.A.

Table 7.8 shows the projects undertaken during the first three Plans:

Table 7.8

Plan Projects in Jammu Region

Name of Project	Type	Ultimate benefits (thousand hectares)	Districts benefited
1	2	3	4
	A. First Plan Projects		
	(i) *Completed during 1st Plan*		
Udhampur Canal	..	0.40	Jammu
	(ii) *Completed during 2nd Plan*		
	Nil.		
	(iii) *Completed during 3rd Plan and Annual Plans 1966-69*		
Pratap Canal	Canal	8.70	

Table 7.8—Contd.

Plan Projects in Jammu Region

Name of Project	Type	Ultimate benefits (thousand hectares)	Districts benifited
1	2	3	4
B. SECOND PLAN PROJECTS			
(i) *Completed during 2nd Plan*			
Nil.			
(ii) *Completed during 3rd Plan and Annual Plans 1966-69*			
Kathua Feeder	..	9.92	Madhopur
C. THIRD PLAN PROJECTS			
Nil.			
D. ANNUAL PLAN (1966-69) PROJECTS AND 4TH PLAN PROJECTS			
Dudhar Canal	..	2.83	..
Remodelling of the Ranbir Canal	Canal	N.A.	

Source: CW & PC Note Volume Jammu & Kashmir, March, 1970.

Ground Water

7.21 Since November 1966, thirty tubewells have been either completed or are nearing completion in Jammu district. It is proposed to increase their number to 78 and to provide irrigation to an area of 7,689 hectares of uncultivated land, and also to supplement supplies in the Ranbir Canal. The State Government proposes to popularise Mexican wheat and hybrid maize in tubewell areas.

Fourth Plan Programme

7.22 The State Government had proposed a number of major and medium schemes to be implemented during the Plan. Some of the proposed schemes are:

(i) The first phase of the Ravi-Tawi, irrigating 12,140 hectares;
(ii) The Pargwal Canal irrigating 2,938 hectares;
(iii) The Munawar Tawi Scheme irrigating 3,237 hectares; and
(iv) The Painthal Canal irrigating 2,428 hectares.

The remodelling of the Ranbir Canal is expected to be completed. It will irrigate 405 hectares of new areas and stabilise irrigation on 12,140 hectares of the existing command. The Dudhar Canal Scheme will create

after completion during the Fourth Plan period, an additional irrigation potential of 22,565 hectares, and irrigation on 21,338 hectares will be stabilised through major and medium schemes.

In the Jammu area, the outlays during the Fourth Plan period are:

Continuing Schemes	Rs. 6.78 million
New Schemes	Rs. 9.98 million
Total	Rs. 16.76 million

Water Rates

7.22 The water rates charged as 'abiana' in the Jammu Province for both flow and lift are shown below:

1. Sugarcane	Rs. 6.48 per acre
2. Paddy	Rs. 6.48 per acre
3. Vegetables & orchards	Rs. 5.04 per acre
4. Maize, wheat and bila kero	Rs. 2.64 per acre
5. Kero crops	Rs. 0.96 per acre
6. Fodder, rabi crops	Rs. 5.04 per acre
7. Other crops, pulses etc.	Rs. 2.48 per acre
8. Rooni	Rs. 0.80 per acre
9. Lift irrigation (wet crops)	Rs. 16.00 per acre

The Ladakh Plateau

7.23 Ladakh is the highest plateau of India (average elevation 5,300 m). It is steppe country, high and arid. The Zojila Pass (3,529 m.) in the Great Himalayas is the only link, through Kargil, between Ladakh and the rest of Kashmir. North-eastern Ladakh has an inland drainage system with the rivers draining into small lakes. The general slope of the land is towards the north.

Ladakh gets very little rain (8.28 cm. per annum). The winter precipitation there is most important. Devoid of any forest cover, cultivation of crops there without irrigation is practically impossible. The economy of Ladakh is at a very low level. Ladakh covers about 17 per cent of the total geographical area of the State, but it has only 2.5 per cent of the population. This population lives in small villages located near the rivers. The cropping pattern is dominated by low value crops, such as barley, which covers 40 per cent of the area, pulses (16 per cent) and wheat (16 per cent). The soils are generally sandy and per-hectare yields are very low. Recently, the cultivation of fruits and vegetables, primarily for supply to army units stationed in the area, has increased.

Since no cultivation is possible without irrigation, the State has planned three schemes in the Fourth Plan at an overall cost of Rs. 2.1 million.

The three schemes are:

(1) The Abichannothang Canal in Leh (486 hectares);

(2) The Upstri Canal in Leh (223 hectares); and

(3) The Gargarthan Irrigation Scheme in Kargil (121 hectares).

In addition, it has planned to begin the Khumbathang Irrigation Scheme in Kargil to irrigate 393 hectares. Its cost will be Rs. 1.18 million.

In the Fourth Plan, it is also proposed to start the Stakna Irrigation Project in Leh to irrigate 1,443 hectares at a cost of Rs. 3.2 million. The project is still under the scrutiny of the CW & PC.

Tours, Observations and Recommendations

7.24 The Commission visited Jammu & Kashmir between the 18th and the 24th October, 1970. Discussions were held with the Chief Minister, the Irrigation Minister and senior officers of the Jammu & Kashmir Government. During the tour in the Kashmir Valley, the Sonawari area, the Sind valley irrigation system, the Jhelum outfall channel in the Baramula area and several lift irrigation and reclamation schemes in Srinagar and Anantnag were visited by us. The Commission also saw the Dudhar canal system, the Ranbir canal, the Kathua canal and the Tawi lift irrigation scheme in Jammu Province.

7.25 During our visits to the lift irrigation schemes from the Jhelum and its tributaries, we were given the impression that some of the schemes had been held up for want of steel. The quantiites of steel required were small, and we suggest that the Central Government should assist the State Government to get its requirements of steel on a priority basis.

By improving the position of power supplies in the Valley, irrigation through lift schemes could be considerably increased. The karewas which are unirrigated at present, could be irrigated either by lift from the river Jhelum or from tubewells. Lift from the Jhelum or any of its tributaries would involve lifts of more than 60-90 m. It was suggested to us by the State Government that the Central Ground Water Board be requested to carry out investigations on the karewas for ground water.

7.26 These karewa lands are particularly suitable for growing cash crops like kuth, fruit, flower seeds, vegetables, almonds, safron etc. If lift irrigation schemes on the 'karewas' are properly designed, irrigation could be done through sprinklers.

7.27 One of the hurdles in the way of multiple cropping, particularly

where a second wheat crop is raised after the harvesting of paddy, is the shortness of time available for preparing lands for wheat sowing. Earlier in this Chapter in section 7.7, we have discussed this question in some detail. However, apart from the recommendations which were made in that section, we would suggest that the preparation of the land for wheat sowing could be quickened by the use of tractors.

Up to now, water has not been a limiting factor for paddy cultivation but as irrigation is extended, the snowmelt and rainfall run-off may not be sufficient to meet the entire requirements of the paddy growing areas. The need to supplement river flows with ground water is, therefore, obvious.

7.28 During the course of our tour, we noticed that large areas on the hill slopes have been denuded of vegetation. In Chapter XIV of Volume I of our Report, we have dealt with the question of soil conservation and its bearing on the control of sedimentation. We were happy to learn from the Chief Conservator of Forests that the State Government has planned programme for afforestation in all the catchment areas in the State. The farmers are also being educated to appreciate the importance of terracing and levelling land on hill slopes. This will, we hope, arrest further erosion of hill slopes.

7.29 The State Government has prepared a plan to expand irrigation to 'Kandi' areas by gravity flow from the Ravi and its tributaries and by lift irrigation schemes, including lift through the tubewells. Of these schemes the Tawi lift irrigation scheme is in progress but work on this and other schemes could be expedited if more funds were to be allocated. We were told that the main handicap is the shortage of money.

A number of tubewells have been constructed in the southern portion of Jammu, but we found that the development of irrigation in the commands of tubewells has not been satisfactory. The farmers are experiencing difficulties in levelling their lands and in constructing field channels. We are definitely of opinion that the flow rates of irrigation in the State are abnormally low, and they should be raised, which will incidently reduce and finally remove the disparity between the flow and tubewell rates.

7.30 We have generally refrained from making observations on the service conditions of engineers in the States. But Kashmir, because of its peculiar topography and communication problems, is a special case. We are of opinion that the question of giving a special allowance to engineers posted in out-of-the-way and unattractive places, deserves an examination by the State Government. We make this recommendation more in the interest of administrative efficiency. We also gathered the impression that far too many engineers have been serving for too long in temporary posts

and would like this matter to be looked into by the State Government. Our observations in this regard in Chapter XII of the First Volume of the Report are relevant.

7.31 The Chief Minister drew our attention to the fact that the Indus Water Treaty limits the use of the waters of the Chenab in Jammu and this stands in the way of further expansion of irrigation there. The State Government feels that the Treaty should be revised so that more water from the Chenab and its tributaries can be available in Jammu Province.

KERALA

Comprising the former Princely States of Travancore and Cochin, the Malabar district and the Kasargod taluk of the erstwhile State of Madras, Kerala, as it is today, came into being on the reorganization of the States in 1956.

It is located between 8° and 12° N latitude in the extreme south-west of the peninsula, and is washed, along the whole of its western coast, by the waters of the Arabian Sea. To the east, the Western Ghats loom like a wall with a major breach in its ramparts only in the Palghat Pass, though there are several smaller passes.

The 88 towns and 1,575 villages which shelter a population of 21.28 millions, are crowded together in 38,864 sq. km. of territory. The density of population is as high as 548 persons per sq. km. against the average density of 182 for India as a whole.

About 58 per cent of the total working force depends on agriculture, with paddy as the predominant crop. After paddy, come coconut and tapioca. Rubber, tea, coffee, cashewnut, arecanut and pepper are grown extensively and are valuable earners of foreign exchange.

The rainfall in Kerala is heavy. Its topography is undulating. The State is criss-crossed by streams and rivers, of which 41, rising in the Western Ghats and flowing into the Arabian Sea, are important. These westflowing rivers have an average length of only 60 km., and only four of them, namely, the Beypore, the Bharatpuzha, the Periyar and the Pamba exceed 160 km. in length. Although small these rivers carry sizeable flows during the heavy south-west monsoon rains.

There are only three rivers which flow eastwards into the basin of the Cauvery, namely, the Kabbani, the Pambar and the Bhavani.

Before 1947, Kerala had no irrigation to speak of. It depended on the heavy rainfall of the south-west monsoon to raise one, or even two, paddy crops in a year. In lowlying areas which accumulated water, even a third crop could be grown. However, the crops depended for their success on the rains. To lessen the dependence on rainfall, the State Government has constructed a number of irrigation works since 1951. The most important of these are the Malampuzha Project irrigating 38,500 hectares,

the Chalakudy irrigating 39,400 hectares, and the Neyyar Project irrigating 30,400 hectares. By 1968-69, nearly 20 per cent or 0.583 million hectares of the gross cultivated area of 2.853 million hectares, was irrigated.

A unique and satisfactory feature of most of the major and medium schemes in the State is the double cropping of almost all the land in the ayacuts.

Among the projects at present under construction are the Periyar Scheme (41,000 hectares), the Pamba Scheme (34,000 hectares), the Kuttiyadi Scheme (31,000 hectares) and the Kallada Scheme (105,200 hectares). A scheme for flood protection has been completed to benefit nearly 50,000 hectares.

Physiography

8.3 The State can be divided roughly into three distinct regions:

(i) The coastal belt;

(ii) The midland plain;

(iii) The heavily forested hills to the east of the Western Ghats.

The coastal belt is a narrow strip of land running from the extreme south of the State, north to Kozhikode. Still further north, the cliffs of the Western Ghats rise almost at the shore line. A characteristic feature of the belt is the large number of picturesque lagoons and backwaters which have their beds a metre or more below mean sea level. During the rains, most of these backwaters are connected to the sea by creeks, locally called 'Pozhi'. This area has dense coconut plantations, and is intensively cultivated with paddy.

The long coast line is subject to heavy erosion during the monsoon months, and the steady and remorseless encroachment of the sea on the narrow coastal strip spells danger to the future of the State.

The central plains which stretch westwards from the hills to the coastal areas, are heavily cultivated and intersected by a large number of rivers flowing westwards into the Arabian Sea. Most of these rivers are tidal in their lower reaches.

The hilly area to the east of the Western Ghats is densely forested and traversed by numerous small streams. The Western Ghats have an average elevation of 1,500 m. though some of the higher peaks rise to 2,400 m. In the extreme north of the State, they run parallel to the coast at a distance of about 32 km., as far as Vavulmala, abreast of Calicut. At this point, they bend sharply eastwards and then northwards round the Nilamboor valley where they recede as far as Vadamala, north of the Palghat Pass, at which point the elevation is only 300 m. South of the pass, they again rise to about 2,000 m. in the Tenmala, and to greater elevations in the Annamalai range.

Some of the more important peaks of the Western Ghats, in Kerala, are Mukurti (2,554 m.), Nilgiri (2,472 m.), Anginda (2,386 m.), Anamudi (2,694 m.), Pullangudi (1,939 m.), Sivagiri (1,751 m.), and Agastier (1,867 m.). Among the numerous passes, the Cherumpidi gives access to Coorg, the Periyar and Tamarasseru, to Wynad and Mysore, and the Kasturi to the Nilgiri district.

Soils

8.4 In the coastal taluks of Cannanore, Kozhikode and Palghat districts, there is a narrow belt of arenaceous soils. In the plains of these districts, there are rich ferruginous soils composed of a mixture of clays and river sand. Except in the Ponnani and Chittur Taluks, the predominant soil is red loam. Clay is found in areas which suffer inundation during the monsoons, and in the beds of the shallow lakes and lagoons of Ponnani.

In the district of Trichur, the predominant soil consists of red ferruginous material. On the slopes of the Ghats, the typical black humus, formed of decaying vegetable matter is found in some areas, while in the middle zone, there are laterite soils varying in quality from rich loams to more or less uncultivable laterites. The low-land areas have arenaceous soils consisting mostly of recent deposits of sand and silt brought down by the rivers.

Swamp and peaty soils occur in the low-lying areas of the Kottayam district, though in the hills of this district the soils are loamy with a rich mixture of humus. The soils in the district are generally deficient in nitrogen, phosphorus and lime.

In the coastal tract of the district of Quilon, the soil is almost pure sand. The swampy, peaty fields have clay of varying depths and with varying proportions of organic matter. Alluvium, consisting of fine silt, covers the valley bottoms, and the river deltas. The hill soils are loamy with a mixture of humus. Generally speaking, the soils of the district are deficient in nitrogen and phosphorus, while the sandy soils along the coast are also deficient in potash.

In the extreme southern portion of the State, the soils fall into three categories. In the highlands, it is black clay loam of lateritic origin with an admixture of sand and gravel. In the valleys, it is loamy clay mixed with a high proportion of sand. In the coastal strip, the soils are sandy.

Climate

8.5 Because of the differences in topography and physical characteristics, the various regions of the State display different climatic characteristics. At higher elevations in the Ghats, temperatures vary from 7° to 16°C in March and April, and from 1° to 16°C from November to

January. In the plains, temperatures range from 21° to 27°C. The coastal areas have high humidity which goes up to 90 per cent, though the percentage diminishes as one proceeds from the coast towards the Ghats. Nowhere in the State is humidity less than 70 per cent.

Rainfall

8.6 Kerala is one of the heavy rainfall areas of the country, the range being from 152 cm. to 510 cm., with an average of 305 cm. The two monsoons account for 90 per cent of the precipitation which is heaviest on the eastern edge of the hills (510 cm.), and the lightest to the east of the Palghat Pass and on the southern borders of the State (152 cm.).

Land Use and Cropping Pattern

8.7 Agriculture is the predominant occupation. Table 8.1 gives the statistics of land utilisation during the year 1968-69, the latest year for which such statistics are available.

Table 8.1

Land Use Pattern

(1968-69)

Classification	Area (thousand hectares)	Percentage of Reporting area
1	2	3
1. Geographical area	3,886	
2. Reporting area	3,859	100.0
3. Forests	1,056	27.4
4. Land not available for cultivation		
(a) Area put to non-agricultural uses	251	6.5
(b) Barren and uncultivated land	80	2.1
Total:	331	8.6
5. Other uncultivated land excluding fallow land		
(a) Permanent pastures	28	0.7
(b) Land under miscellaneous tree crops and groves not included in sown area	150	3.9
(c) Cultivable waste land	89	2.3
Total:	267	6.9

Table 8.1—Contd.

Land Use Pattern

(1968-69)

Classification	Area (thousand hectares)	Percentage of Reporting area
1	2	3
6. Fallow land		
(a) Fallow lands other than current fallows	28	0.7
(b) Current fallows	23	0.6
Total:	51	1.3
7. Net area sown	2,154	55.8
8. Total cropped area	2,853	..
9. Area sown more than once	699	..
10. Net area irrigated	418	..
11. Gross area irrigated	583	..
12. Percentage of net area irrigated to net area sown	19.4	..
13. Percentage of gross area irrigated to total cropped area	20.4	..

Source: Directorate of Economics and Statistics, Union Ministry of Agriculture.

8.8 The major crops in Kerala are rice, coconut and tapioca. In 1968-69, nearly 64 per cent of the total cultivated area was under food crops. Much of its cultivated area is under cash crops, like rubber, cashew-nut, coffee, tea, cardamom, areca nut, pepper and ginger. Table 8.2 gives the cropping pattern in the year 1968-69.

Table 8.2

Cropping Pattern

(1968-69)

Crop	Area (thousand hectares)	Percentage to total cropped area
1	2	3
Rice	874	29.3
Jowar, ragi and other cereals	13	0.5
Total cereals and millets	887	31.1
Pulses (tur and others)	42	1.5
Total foodgrains	929	32.6

Table 8.2—Contd.
Cropping Pattern
(1968-69)

Crop	Area (thousand hectares	Percentage to total cropped area
1	2	3
Sugarcane and others	17	0 6
Condiments and spices		
Pepper	99	3.5
Cardamoms	47	1.6
Betelnuts	81	2.8
Chillies, ginger, turmeric and others	38	1.3
Total:	265	9.2
Fruits and vegetables		
Cashewnuts	96	3.4
Mangoes, bananas and others	178	6.2
Tapioca	297	10.4
Sweet potatoes and others	39	1.4
Total:	610	21.4
Total Food Crops	1,821	63.8
Oilseeds		
Coconut	686	24.0
Groundnut and others	33	1.2
Total:	719	25.2
Cotton	6	0.2
Rubber	169	5.9
Tea	41	1.4
Coffee	23	1.2
Tobacco and others	2	0.1
Other non-food crops	67	2.2
Total non-food crops	1,032	36.2
Total cropped area	2,853	100.0

Source: Directorate of Economics and Statistics, Union Ministry of Agriculture.

Of the 64 per cent of land under food crops, rice accounted for 29.3 per cent, tapioca for 10.4 per cent, fruits (including cashewnuts) for 10.0 per cent, and condiments and spices for a further 9.2 per cent. Coconuts accounted for 24.0 per cent of the total cropped area, while rubber, coffee, tea etc. accounted for 8.5 per cent.

Agricultural Production

8.9 Agriculture in the State is characterised by a high proportion of cash crops, a high intensity of cropping, and high yields. The consumption of fertilizers in Kerala per unit area is one of the highest in India. Excluding the plantations, it is estimated that the intensity of cropping is as high as 130 per cent.

The average yield of rice in 1970-71 was 1,453 kg per hectare, against the all-India average of 1,134 kg per hectare. In the matter of rice yields, Kerala has been outstripped only by Jammu & Kashmir, Mysore, Tamil Nadu, Haryana and Punjab.

The rice is the staple food of Kerala's millions, but Kerala produces just over 50 per cent of its annual requirements of 21.5 million tonnes. To increase rice production in the Fourth Plan, the State Government had proposed a far-reaching paddy production programme, based on the Yelah* or Padasekharam,** as the basic unit. In each Yelah, all the cultivators would co-operate in the procurement and application of 'inputs', and application of improved farming practices. The State will provide assistance by way of credit, technical know-how and legal safeguards. The State Government hopes to increase per hectare yield of paddy hundred per cent through this programme.

The highlights of the programme are ensuring

(i) the infra-structural requirements of each Yelah by improved irrigation and through a production-oriented layout;

(ii) the supply of essential inputs, like water, fertilizers, seeds, credit, pesticides, improved agricultural machinery and technical know-how;

(iii) the co-operation of the farmers by organizing Yelah committees, and a voluntary labour force to build up the infra-structure.

Paddy areas, 200 hectares in size, whether held individually or collectively, would form an operational unit. Such areas will be marked out in every district. All production activity will be concentrated in and on these 200 hectare units.

The districts which are proposed to be covered, the aggregate areas involved in each district, and the number of production units are given in Table 8.3.

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*A small unit for purposes of irrigation and drainage.

**A field complex formed of several holdings with a common outer bandh.

Table 8.3

Details of District-wise Areas Proposed under the Paddy Production Programme

District	Area (hectares)	No. of units
1	2	3
Trivandrum	10,000	49
Quilon	13,200	65
Alleppey	18,200	90
Kottayam	16,200	80
Palghat	18,200	90
Cannanore	33,500	166
Total :	109,300	540

Water Resources

8.10 The average annual run-off from the west and east-flowing rivers taken together, is estimated at 69,575 m.cu.m, of which only 5,550 m.cu.m is from the east-flowing rivers. The steep slopes of the river beds and the rapid drop in elevation from the source to the sea, makes them an ideal source of hydro-power. The power potential of these rivers has been estimated to be 2 million KW at 60 per cent load factor. Table 8.4 gives the salient features of those rivers in the State with a catchment area of 1,000 sq. km. or more.

Table 8.4

Area Drained by the Rivers and Their Average Annual Run-off

Name of the river	Drainage area within Kerala		Average annual run-off
	Sq. km.	Sq. miles	(TMC/m.cu.m)
1	2	3	4
1. Periyar	5,200	1,996	428.0/12,120
2. Bharatapuzha	3,800	1,492	221.5/ 6,270
3. Chaliyar (Beypore)	2,400	940	160.5/ 4,540
4. Pamba	1,950	753	222.8/ 6,310
5. Kabbani (east-flowing)	1,950	753	145.0/ 4,110
6. Kallada	1,540	600	76.0/ 2,150
7. Muvattupuzha	1,500	588	93.7/ 2,650
8. Meenachil	1,170	456	92.3/ 2,610
9. Achenkoil	1,140	446	76.0/ 2,150
10. Kadalundi	1,100	430	77.3/ 2,190
11. Chalakudy	1,000	391	75.9/ 2,150

Source: Water Resources of Kerala (Advance Report)—1958.

Since Kerala gets rain both from the south-west and from the north-east monsoon, its rivers hold water throughout the period from June to December, with the maximum discharge during the months from June to September. From January to June when the south-west monsoon breaks, the rivers carry greatly diminished flows. Table 8.5 gives the percentage of yield in various rivers during different periods of the year.

Table 8.5

Seasonal Distribution of the Yield of Principal Rivers

Name of the river	Percentage yield			Year for which average has been worked out
	June-Sept.	Oct.-Dec.	Jan.-May	
1	2	3	4	5
1. Periyar	77.5	18.5	4.0	1964
2. Bharatapuzha	72.0	26.0	2.0	1964
3. Chaliyar (Beypore)	81.5	7.0	11.5	1964
4. Pamba	74.5	24.5	1.0	1964
5. Kabbani	22.5	77.5	..	1964
6. Kallada	51.5	44.0	4.5	1966
7. Muvattupuzha	68.0	27.0	5.0	1964
8. Meenachil	72.0	26.0	2.0	1964
9. Achenkoil	59.1	39.7	1.2	1964
10. Kadalundi	62.0	36.0	2.0	1964
11. Chalakudy	79.0	19.0	2.0	1964

Source: State's replies to the Questionnaire.

8.11 River gauging stations have been established on various rivers in the State, and it is proposed to cover all the rivers in due course. Discharge data for important rivers, such as Periyar, Bharatapuzha, Chalakudy, Muvattupuzha, Keecheri and Karuvannur have been recorded from 1963, and for the Chaliyar, Kuttiyadi, Valapattanam, Chandragiri, Kabbani, Meenachil, Pamba, and Kallada from 1964.

Ground Water

8.12 Very little has so far been done to assess the ground water potential in the State. The exploitation of ground water is at present negligible. The State Government prepared a scheme for the quantitative assessment of the ground water resources of the State. Once the survey is completed, planned exploitation will follow. Studies carried out by the Geological Survey of India, covering an area of 1,035 sq. km. in Alleppey district,

have indicated that shallow aquifers exist within 3-5 m. of the ground surface.

Experimental tubewells sunk to a depth of 64 m. yielded 50,000 to 43,650 litres per hour. It has been stated as a result of the survey that appreciable amounts of water could be drawn from depths up to 122 m.

Present Stage of Development of Irrigation

8.13 Irrigation in Kerala before 1951 was negligible, and confined to minor works. In that year, however, a number of major and medium works were undertaken so that, by 1968-69, nearly 20 per cent of the gross cultivated area of 2.853 million hectares in the State was brought under irrigation.

8.14 Some important projects are described briefly in the following paragraphs.

Malampuzha Project: This dam on the Malampuzha river in Palghat district is a composite dam 38 m. high and 1,849 m. long. The left and right bank canals, with a capacity of 85 and 28 cumecs respectively irrigate an area of 19,263 hectares. The whole command area of the dam is double-cropped, and the gross annual irrigated area comes to 38,527 hectares. Begun in 1949, the project with its distribution system was completed in 1967 at a cost of Rs. 58 million.

Periyar Valley Project: The project estimated to cost Rs. 95.4 million comprised a barrage across the river Periyar at Palanchode in Ernakulam district. The work on the project started in 1956 and is expected to be completed in the Fourth Plan. The length of the barrage is 211 m. About 25,600 hectares are expected to be irrigated within the command of the left and right bank canals. The gross irrigated area will be 40,996 hectares.

Pamba Irrigation Project: Work on this project began in 1956 and is expected to be completed by the close of the Fourth Plan. It consists of a 80 m. long barrage with two canals to irrigate a gross area of 34,000 hectares in Quilon district.

Kuttiyadi Irrigation Project: It is proposed to construct a dam 171 m. long and 35 m. high across the Kuttiyadi river in Kozhikode district at a cost of Rs. 52.4 million. The dam will be of masonry with earthen flanks, and will have a live storage capacity of 113 m.cu.m. It is expected to irrigate a gross area of 31,162 hectares and will be completed during the Fourth Plan period.

Kallada Irrigation Project: Work on this project which is expected to be completed in the Fifth Plan, started in 1962 on the Kallada river in Quilon district. It is the largest irrigation scheme in Kerala and will pro-

vide irrigation to a gross area of 105,220 hectares at a cost of Rs. 144.9 million. The live storage capacity of the dam will be 510 m.cu.m.

The State has also undertaken a number of medium irrigation schemes. By 1969, one major and nine medium schemes had been completed to bring irrigation to about 173 thousand hectares. Appendix 8.1 shows the salient features of all projects undertaken so far in the State and irrigating four thousand hectares or more.

Minor Irrigation

8.15 In 1951, as many as 165 thousand hectares were being irrigated by minor irrigation schemes and by 1964-65 this figure had risen to 229 thousand hectares. The contribution from ground water was, however, almost negligible and the area was irrigated overwhelmingly from surface water sources.

By 1968-69 net area irrigated from all sources was 418 thousand hectares, distributed as follows:

	Thousand hectares
Government canals	189
Private canals	10
Tanks	71
Wells	6
Other sources	142
Total	418

The gross area irrigated that year was 583 thousand hectares of which 470 thousand hectares was under paddy.

Ayacut Development

8.16 The main difficulty in the speedy utilisation of the water potential in Kerala, as in other States, is the delay in the construction of water courses and field channels. This delay is aggravated, because in this State the alignment of distributaries were used to be taken up after the completion of the main works. The excessively small size of holdings, makes the farmer reluctant to part any land for water courses and field channels. It works harder on small peasants. We are of opinion that the State is ideally suited for laying underground pipes to convey water to fields, and save land for agricultural use.

We found that in some parts of the State, the Irrigation Department takes responsibility for supply of water to 40 hectare blocks. Within these blocks

the farmer has to construct field channels at his cost. We consider the area of 40 hectares to be too large for the farmers to control, especially because of large number of petty holders involved. The laying of underground pipes would need an amount of expertisation which is beyond the capacity of the farmer. We are of opinion that the pipes should be laid by the Irrigation Department and reach individual fields. The cost may be recovered from the beneficiaries.

Land levelling is not a major problem in the State, except in the Neyyar Project, where the lands have to be levelled to convert them from dry land to wet lands. The farmers are unable to finance the operations of levelling from their own resources and the work has made little progress. We were given to understand that the State Government has prepared a programme of land-shaping for implementation in this area over a period of five years. It will cost about Rs. 25.6 million, which will be advanced as loans to farmers and recovered in instalments.

Future Development of Irrigation

8.17 The State Government proposes to undertake a number of new projects during the Fourth Plan. The details of these projects are given in Table 8.6.

Table 8.6

Details of New Projects Proposed under the Fourth Plan

Name of the Project	Benefits (Thousand hectares)	Estimated cost (Rs. million)
1	2	3
Bhavani Valley	3.25	9.0
Karapuzha	10.52	20.0
Chimovi	16.19	25.0
Kuriakutty	34.82	50.0
Kakkadavu	20.23	50.0
Silent Valley	32.40	35.0
Idikki	97.13	112.5
Vamanapuram	23.47	51.0
Mupli	24.30	20.0
Total:	262.31	372.5

Besides, there are 21 other schemes under investigation in various river basins, which, if found feasible, will eventually benefit 288 thousand hectares.

By August, 1969 a sum of Rs. 160 million had been spent in the State on irrigation works. The following table gives figures of the estimated future expenditure on continuing schemes, new projects to be undertaken in the Fourth Plan and the projects under investigation.

Table 8.7

Costs and Benefits of the Continuing Schemes, New Fourth Plan Projects and the Projects under Investigation

Item	Estimated cost (Rs. million)	Estimated benefits (Thousand hectares)
1	2	3
Projects continuing into Fourth Plan	316	241
New projects proposed for the Fourth Plan	373	262
Projects under investigation, to be taken up in the future	627	288
Total:	1,316	791

Floods

8.18 Floods in Kerala are frequent and often of great severity. The heavy rain during the south-west monsoon causes streams and rivers to overflow and to inundate the countryside. The worst effects of the floods are felt in the midlands and the coastal belt.

During the Second Plan a flood control body was constituted to deal with the problem systematically, and, in the Third Plan, a sum of Rs. 6.1 million was spent on flood control works to protect an area of 4,300 hectares.

Flood control schemes included in the Fourth Plan are the improvement of Champakarathodu, opening the Irumbanam-Puthussery-Nadamil Canal and the Keeranllur-Pooraparamba Canal.

Salinity Control

8.19 Almost all the rivers in Kerala are tidal. They flow through low flat lands, connected to the sea by tidal creeks, so that the problem of salinity is serious.

During the rainy season, the freshwater run-off is sufficient to flush out the salt water from the tidal reaches of the rivers and from the backwaters. However, after the rains, when the discharge of fresh water in the rivers is reduced, salt water from the sea travels up the creeks into the coastal areas for distances up to 25 km. These tidal runs contaminate the rivers and streams, making the water in them unfit either for drinking or for irrigation. The salt water covers low-lying fields and is drawn up by capillary action into adjacent highlands. Where clay bunds enclose the low-lying land, the saline intrusions occur through seepage, or when the bunds are breached.

The areas most susceptible to saline intrusions are also the most densely populated and the most intensively cultivated. Since there are no storages for impounding the run-off from the rivers and then release it in a steady and continuous flow the ideal method of leaching the salts is not practised. The alternative, though much less effective, method, is to build regulators, barriers, across streams to keep out the salt water. However, because of the need of salt water for the coir industry, it is not possible completely to shut off all ingress of salt water. The salt exclusion works in use at present, largely consist of bed-regulators fitted with shutters, which can be lifted to allow the flood flows to go out to sea, and which can then be lowered to prevent ingress of sea water and of tidal flows.

One of the most extensive of such salt exclusion schemes is at present under construction. This is the Thanneermukkom Regulator across the Vembanad lake, which will protect 50,000 hectares of land at a cost of Rs. 15 million.

In the Master Plan prepared by the State for salinity control, there are 13 schemes costing Rs. 40 million to protect 25,000 hectares. In the first phase which is expected to be completed by 1971, 19,000 hectares will be protected. The second phase to be completed by 1991, will cost Rs. 20 million and will protect 6,000 hectares.

Waterlogging

8.20 About 10 per cent of the paddy fields in the ayacut of the irrigation projects in the State is waterlogged. These fields are dewatered by pumping out water during the cultivation season. The intensive cultivation of the hill slopes has resulted in soil erosion and consequent silting of drainage channels. The restricted waterway of the drainage system has in turn caused waterlogging. Lack of maintenance, and encroachment on the drainage channels has aggravated the situation. We would draw the attention of the State Government to our recommendations in Chapter XIII of Volume I of our Report, particularly to those regarding the necessity for efficient drainage and the maintenance and inspection of drains.

The inadequacy of the outlets into the sea is another factor contributing to waterlogging. Some works have been undertaken to improve these outlets. The Thottappally spillway on the National Highway in Alleppey district is the most important among such works. The construction of a spillway has helped the discharge of flood flows into the sea and thus eased the flood problem in the Kuttanad region to a great extent. An outlet to the sea is also proposed at Kuttamangalam in the Trichur Kole area.

Drainage

8.21 It is a major problem only in the coastal areas, where thousands of hectares are brought under cultivation after the south-west monsoon. The land in these areas is divided into blocks, not exceeding a few hundred hectares each, and enclosed by clay bunds erected at considerable expense. To get rid of surplus water, dewatering pumps are installed. Flood control measures will, we hope, make the maintenance of bunds easier. The largest of these schemes is at Kuttanad.

Sea Erosion

8.22 The entire 580 km. length of the Kerala coast is exposed to the fury of storm lashed waves and is, therefore, being constantly eroded. At some places near Cochin, strips of land from 5 to 10 m. in width are lost to the sea every year. Studies carried out at the Central Water & Power Research Station, Poona, have shown that sea-walls and groynes are the only devices to arrest encroachment and erosion by the sea.

In the First Plan, an experiment of constructing a sea-wall was taken up to protect 1.6 km. of the worst affected area of the coast. In the Second Plan, sea-walls were erected to protect about 25 km. of the coast and in the Third Plan, a further 58 km. were protected in the same manner. It would cost Rs. 300 million to construct the 320 km. of sea-wall to protect the most vulnerable sections along the coast.

Betterment Levy

8.23 Under the Travancore-Cochin Irrigation Act, 1956, as amended by the Kerala Adaptation of Laws Order of the same year, the State Government is empowered to levy a betterment contribution from the landholders of any land in the State, except Malabar district, which, in its opinion, is benefited by any major irrigation work, the construction, extension or alteration of which has been undertaken by the State Government on or after January 1,1943.

The betterment levy is calculated as follows:-

(i) The lands benefited by the construction, expansion or alteration of any major irrigation work are divided into suitable classes by the State Government and the annual increase in the gross produce of each class of land, consequent on the provision of irrigation facilities, is estimated.

(ii) The annual increase in gross produce is estimated with reference to the average of prices prevailing during the five years immediately preceding the date when the estimate was made.

(iii) Twenty times the annual increase in the gross produce estimated under (i) is deemed to be the increase in the capital value of each class of land, one-fourth of the increase in the capital value minus the cost of making the land fit for irrigation is payable in respect of that class of land as betterment levy. It may be paid by the landholder in twenty equal annual instalments. If paid in full in one instalment, a rebate of 20 per cent is allowed. The levy became payable two years after the commencement of irrigation.

The recovery of betterment levy in Kerala has been extremely poor. During 1960-61, only Rs. 0.1 million was collected and in subsequent years the collections have even been less. In 1968-69, it stood at a bare Rs. 900.

Water Rates

8.24 Water rates in the areas which were a part of the erstwhile Travancore-Cochin State, are different from those in Malabar, and vary according to the type of irrigation and the type of land. Water rate collections within the command of minor schemes have remained suspended since 1967. The rates for different areas are given below:

Travancore-Cochin Area

Petty Irrigation (benefiting 5 acres and less)

The construction of petty irrigation works is the responsibility of the concerned Panchayat. According to section (4) of Travancore-Cochin Irrigation Act, the Panchayat can levy a cess on the basis of an average but it shall not exceed Rs. 3.50 per acre.

Minor Irrigation (Up to 200 acres)

According to section 5 of the Act, the cess should not be above Rs. 3.50 per acre.

Major Irrigation (200 acres and above)

According to section 15(3) of the Act, the rates of the cess will be as follows:-

(a) Land already registered as single crop wet lands but on which two or more paddy crops could be raised.	Rs. 6 per acre
(b) Other lands already registered as wet land.	Rs. 6 per acre
(c) Lands made fit for cultivation and on which only one paddy crop could be raised.	Rs. 6 per acre
(d) Lands made fit for cultivation and on which two or more paddy crops could be raised.	Rs. 10 per acre
(e) Other lands benefited.	At such rates per acre not exceeding Rs. 10, as may be fixed by the Government from time to time.

Where irrigation is done by bailing or by means of any mechanical contrivance, the water cess leviable would be 50 per cent of the rates specified above.

Malabar Area

The rates of cess for irrigation works leviable under the Malabar Irrigation Works (Construction and Levy of Cess) Act, 1947, are prescribed by the rules issued thereunder. The rates are the following:-

Description of Crops	Charges per acre 1st Class source Rs.	Charges per acre 2nd Class source Rs.
(a) Sugarcane, betel, plantain, turmeric and elephant yam	6	4.50
(b) Any other crop which requires water for more than six months	5	4.50
(c) Crops other than those specified in clauses (a) and (b):		

S. No.	First Crop/Second Crop		First class source			Second class source		
			First crop Rs.	Second crop Rs.	Total charges Rs.	First crop Rs.	Second crop Rs.	Total charges Rs.
1	2		3	4	5	6	7	8
1.	Wet	Wet	4.00	2.00	6.00	3.00	1.50	4.50
2.	Wet	dry systematically irrigated	4.00	1.50	5.50	3.00	1.12	4.12

S. No.	First Crop/Second Crop	First class source			Second class source		
		First crop Rs.	Second crop Rs.	Total charges Rs.	First crop Rs.	Second crop Rs.	Total charges Rs.
1	2	3	4	5	6	7	8
3.	Wet dry occasionally irrigated	4.00	1.00	5.00	3.00	0.75	3.75
4.	Dry systematically irrigated wet	3.00	2.50	5.50	2.25	1.87	4.12
5.	Dry systematically irrigated	3.00	2.00	50.0	2.25	1.50	3.75
6.	Dry occasionally irrigated	3.00	1.50	4.50	2.25	1.12	3.37
7.	Dry occasionally wet irrigated	2.00	3.00	5.00	1.50	2.25	3.75
8.	Dry systematically	2.00	2.50	4.50	1.50	1.87	3.37
9.	Dry occasionally irrigated	2.00	2.00	4.00	1.50	1.50	3.00

	1st class source Rs.	2nd class source Rs.
Third crop Wet	2.00	1.50
Dry weather systematically irrigated or occasionally irrigated	1.00	0.75

Lift Irrigation

Lift irrigation schemes can be undertaken by co-operative societies, panchayats and Government agencies. In the case of Government agencies, the rates are as below:

First crop	Rs. 5 per acre
Second crop	Rs. 10 per acre
Third crop	Rs. 15 per acre

If water is supplied for all three crops, a consolidated rate of Rs. 25 per acre is levied. However, in the case of co-operative lift irrigation schemes, the rates are somewhat higher, being Rs. 5 for the first crop, Rs. 15 for the second crop and Rs. 20 for the third crop. There are also the following special rates for certain projects:

Malampuzha, Walayar, Mangalam and Meenkara Projects

(Revenue Department G.O. MS. No. 2330, dated 29.8.1954)

(1)	I & II Wet Crops together or alone on single and double crop wet lands.	Rs.	7.50
(2)	III Wet crop in single and double crop wet lands.	Rs.	5.00
(3)	I & II Wet crops together or alone on dry lands.	Rs.	10.00
(4)	III Wet crop on dry lands.	Rs.	5.00
(5)	Duffasil crops	Rs.	12.50

Tours, Inspections and Observations

8.25 We toured the State of Kerala from the 16th to 20th January, 1971, and had a meeting with the Chief Minister and his colleagues and also with senior officers on the 21st January, 1971 at Trivandrum.

In the course of the tour, we saw irrigation works in northern, central and southern Kerala. We saw lift irrigation scheme at Alwaye and the Kuttiadi Project in Calicut district; irrigation under the Malampuzha Project in Palghat district; and the Periyar Valley Irrigation Scheme. We also visited the Thanneermukkom Regulator under construction, for preventing salt water intrusion into the Kuttanad area and one of the reclaimed blocks in that area. We inspected the Ithikara Yelah Salt Water Exclusion Scheme on the way to Trivandrum. We also saw the anti-sea erosion works at a number of places, including Tellicherry, Cannanore and Purakkad. The Chief Engineer (Irrigation) and the Chief Engineer (Irrigation Projects) and other officers of the Irrigation Department accompanied the Commission during its tour.

8.26 The first thing that struck us was the slow pace of construction work on the various projects. We found that though the department is well equipped to carry out much larger works, the actual amount of work done depends on the Plan allocations. The State is at present spending about Rs. 50 to 60 million a year on irrigation works, although its capability to spend is said to be of the order of Rs. 100 to 120 million. The slow pace of work also leads to an escalation of costs. The Kuttiyadi Project which was originally estimated to cost Rs. 52 million will now cost Rs. 126 million. The Kallada Scheme, which was originally estimated to cost Rs. 86 million will now cost Rs. 145 million. For the other continuing schemes, we were told that an outlay of Rs. 450 million would be required, but only Rs. 270 million has been provided in the Fourth Plan. Expenditure involving Rs. 180 million would thus spill over into the Fifth Plan. The Commission found that the progress of work at Kuttiadi was almost at

a stand-still. The annual allocation of Rs. 8 million for this work had already been spent and even the additional Rs. 2 to 3 million diverted from other sources had been exhausted by the time of the Commission's visit. It is unfortunate that just when construction should have been as its peak practically no work was being done on this dam or on the canal system. It is difficult for the State Government at this stage to close down work on some works and to complete others expeditiously. The only remedy, therefore, lies in finding additional funds. We were given to understand that if an additional assistance of the order of Rs. 30 to 40 million each year could be given for the next 3-4 years, it would be possible for the State to complete some of the major works during the Fourth Plan. These schemes, on completion, would irrigate 0.11 million hectares.

8.27 Another important work needing immediate attention is the Thanneermukkom Regulator. The early completion of this regulator would free a large block of land in the Kuttanad area from salt water intrusion and would help to raise a good crop of rice and even two crops in parts of the area. The project which was commenced as far back as 1958 is still dragging on. The revised estimate for the project is Rs. 44 million and the expenditure incurred to end of December, 1970 is Rs. 18 million. The allotment for 1970-71 was only Rs. 1.7 million. At this rate of funding the project will linger for years. Kerala being a food deficit State, there is urgent need for the speedy completion of this and other projects.

8.28 We are definitely of opinion that no new major work should be taken up for construction in the State of Kerala, unless the projects under construction are nearly completed. Meanwhile investigation work of new projects should continue.

8.29 Numerous streams and rivers criss-cross the entire coastal area in Kerala. Attempts have been made in the past and are being made to lift water from these streams and rivers for irrigation. Even so the area at present under lift irrigation is not large. Hardly a 40 thousand hectares are being irrigated although the scope for expanding lift irrigation is vast. The Commission recommends that a systematic study should be carried out of the various streams and rivers in the State for lift irrigation. The State Government should undertake large schemes and should also encourage the farmers to set up schemes on a co-operative basis.

8.30 Ground water has so far played an insignificant part in the development of irrigation in Kerala. Nevertheless, the ground water possibilities should be explored. The State has recently set up a ground water unit. The Commission hopes that this unit will be suitably

strengthened to complete the work of assessing the ground water resources and its exploitation started.

8.31 The water rates in Kerala are among the lowest in the country. Considering the cost of schemes and the need for taking up a number of fresh irrigation schemes, the State should take steps to revise the water rates. We were informed during discussions at Trivandrum that a proposal for such a revision is under the active consideration of the State Government.

An important matter which needs immediate attention is the question of the unification of irrigation laws. At present there are three major irrigation laws prevailing in force:

(i) The Travancore Irrigation Act;
(ii) The Malabar Irrigation Act; and
(iii) The Cochin Irrigation Act.

We were told during the discussions at Trivandrum that a Bill consolidating these laws has already been framed and the State Government would soon take steps to get it passed. It would help to streamline the procedure for the collection of water rates on a uniform basis, to standardise the rules for field channels to ensure the development of irrigation.

8.32 The State Government has recently constituted an Investigation Circle to re-assess these resources and to explore fresh irrigation possibilities. This work should be expedited and a Master Plan prepared indicating the possibilities of utilising the irrigation potential. Kerala has abundant surface water resources but most of the run-off is during the south-west monsoon. It should be possible to use this water for irrigation through storage dams. Investigations have, therefore, to concentrate on locating good storage sites. If water cannot be fully impounded, the surplus can be diverted to adjacent areas where suitable storage sites may be available. The feasibility of a number of salt water exclusion schemes like the Thanneermukkom or Ithikara Yelah Scheme should also be investigated.

8.33 We noticed that only 32 per cent of the irrigated area in the State raises a second crop. The reasons for the low percentage should be looked into. The State should also examine if some of the coconut plantations could be provided with irrigation water, as we were given to understand that the application of irrigation water increases the production and the quality of coconuts.

CHAPTER IX

MADHYA PRADESH

Madhya Pradesh was formed as a result of the States Reorganisation in 1956 and includes areas of the erstwhile Central Provinces, Vindhya Pradesh and Madhya Bharat. The State is located between 18° and 27° latitude and 74° and 84° longitude. Its boundaries are Gujarat and Rajasthan on the west and north-west, Uttar Pradesh and Bihar on the north and north-east, Orissa on the east and Maharashtra on the south, and Andhra Pradesh on the south-east. It is the largest State in the Indian Union extending over an area of 442,841 sq. km. which constitutes 13.5 per cent of the total area of the country.

According to the 1971 census, the population of the State was 41.65 millions. This constituted 7.6 per cent of the total population of the country. The density of population was 94 per sq. km. against 182 per sq. km. of the Indian Union. Madhya Pradesh is less urbanised than most other States and nearly 84 per cent of its people live in the rural areas. A large number of people belong to Scheduled Castes and Scheduled Tribes. In 1961 this group constituted a third of the population.

Agriculture is the mainstay of the population. According to the 1971 census, 78.44 per cent of the workers in the State were engaged in agriculture as against the national average of 68.62 per cent. The number of persons engaged in mining, industry, commerce, transport and communications and services was much lower than the all-India figures for these sectors.

All the major rivers and their tributaries which rise in Central India, have their catchments in Madhya Pradesh. The Chambal and the Betwa rising in the Vindhya range of the State drain into the Yamuna and the Son river which also originates in the same range, drains into the Ganga. The Narmada, the Tapi and the Mahi rivers flow to the west into the Arabian Sea; the Mahanadi flows to the east into the Bay of Bengal. Important tributaries of the Godavari like the Wainganga, Indravati, Sabari and Pench also drain areas in Madhya Pradesh.

9.2 Important irrigation projects which were in operation before the beginning of the First Five Year Plan were the Tandula Reservoir (1921),

the Mahanadi Canals (1923), the Kharung Tank (1931), the Maniari Tank (1933) and the Harsi Dam (1934). The Chambal Project has been the most important scheme undertaken by the State in the era of the Plan. It is a joint venture with Rajasthan and, on completion, will irrigate 283,000 hectares of land in the State. Other important projects under construction are Tawa (304,000 hectares), Barna (66,000 hectares), the remodelling of the Mahanadi Canals (57,000 hectares) and the Hasdeo Right Bank Canal (47,000 hectares).

Physical Features

9.3 The State can be broadly divided into the following physical regions:

Gird Region: A low lying region including areas north-east of Gwalior and extending over the greater part of Bundelkhand and up to the Kaimur hills in Baghelkhand.

Malwa Plateau: This includes the region between the great Vindhyan barrier, which forms the northern part of the Narmada valley and an area just south of Gwalior. It is a wide table-land with a mean elevation of 488 m above sea level covering nearly 89,610 sq. km.

Narmada Valley: This valley is about 320 km long with an average width of 32 km walled in by the Vindhyas in the north and the Satpuras in the south.

Satpura Ridge: This ridge stretches across the State in the shape of a triangle with the base formed by the Maikala range in the east and extending from Amarkantak in the north to Saletekedi in Balaghat district in the south. The sides of the triangle running westward meet in Nimar. The average elevation of the ridge is about 610 m. above sea level and it forms the water-shed of the plains lying to the north of the ridge.

Chattisgarh Plains: These lie to the east of the Satpura range and are fairly level, except for the few undulations of the Hazaribagh range and the Korea hills.

Vindhya Range: The Vindhya range lying north-east, south-west runs almost through the middle of the State.

Soils, Climate and Rainfall

9.4 The main soil types found in Madhya Pradesh are alluvium, deep black, medium black, shallow or light black, mixed red and black mixed red and yellow and skeletal or gravel soils.

Fertile alluvium is found in Morena, Bhind and Gwalior. The soil of Sheopur (Morena district) is black in colour, clayey in texture, low in soluble salts, neutral in reaction and with a layer of calcium carbonate at a

depth of 0.6 to 1.2 m. The soil of Jora (Morena district) is yellowish brown and less clayey, while that of Bhind is yellow in colour and lighter in texture. In Gohad (Bhind district) saline and alkaline patches have developed due to improper drainage.

The black soils occupy almost half the State and mainly cover the area of the Malwa plateau, the Narmada valley and the Satpura ridge. They vary in depth from a couple of metres to several metres, and are usually loamy to clayey in texture. Lime concretion zones and free calcium carbonate, are invariably present in these soils at different depths; cracks develop in the summer season. These soils can be even 0.9 to 1.2 m deep. There are three sub-types viz. (i) deep black soil (ii) medium black soil and (iii) shallow black soil.

The deep black soil covers the major part of the Narmada valley and the open and level portions of the Vindhya and Satpura plateaus, specially the Hoshangabad and Narsinghpur districts. It has been further sub-divided into black, dark-brown, coarse-brown, mixed and sandy soils. The clay percentage in these soils varies from 20 to 60 per cent.

Medium black soil is the biggest group of black soils and covers the major portion of the Malwa plateau and the districts of Sidhi, Sahdol, Jabalpur, Damoh, Sagar, East Nimar, Raisen and Sehore and the southern part of Shivpuri district. The soil of Jabalpur, Sagar, Mandsaur and Shajapur districts contains 20 to 40 per cent clay while in Vidisha, Guna, Indore, Dhar, Ujjain and Dewas districts, the percentage varies from 30 to 55.

Shallow black soil is spread over the region of the Satpura ridge and covers the Seoni, Chindwara, and Betul districts. It consists of shallow loams with a clay percentage of 15 to 30. The important types met with are dark-brown, clay and loamy rice soils, black soils and poor light hill soils.

Mixed red and black soils are prevalent in the eastern part of the Gird region and in the Rewa, Satna, Panna, Chhatarpur, Tikamgarh and Datia districts and part of Shivpuri district. The commonest form of this soil is sandy clay and it varies greatly in depth and fertility and produces a wide variety of crops under irrigation.

Red and yellow soils are found in the Chhattisgarh plains, the Balaghat district and a part of the Raigarh, Sarguja and Bastar districts. Mixed red and yellow soils occur in this area, which is very suitable for growing rice. This soil is generally light and sandy, though medium and heavy varieties are also found.

In the Durg, Raipur, Bilaspur and Balaghat districts deep clay soils with limestones, yellow sandy loam soils and a mixture of these two, with a medium texture, predominate. In Raipur district, poor red and stony soil is also found, while in Balaghat district dark alluvium covers the areas near the rivers.

Skeletal or gravelly soil covers the uplands of the Vindhya and Satpura ranges and parts of Shahdol, Mandla, Sarguja, Raigarh, Bastar and Jhabua districts. It usually grows inferior millets and oilseeds. It is generally poor, though some patches of good black soil are also met with where crops like rice, wheat etc. can be grown.

9.5 The annual rainfall varies from 760 mm. to 1520 mm. The Mahakoshal region gets between 760 mm. and 1520 mm., the Malwa region between 760 mm. and 1020 mm., the Vindhya Pradesh region between 760 mm. and 900 mm. and the Bhopal region between 760 mm. and 1270 mm.

Table 9.1

Land Use Details—Madhya Pradesh

Classification	Area in thousand hectares	Percentage of Reporting Area
1	2	3
Reporting area	44,357	100.00
Forests	14,609	32.94
Land not available for cultivation		
(a) Area put to non-agricultural use	2,087	4.71
(b) Barren and unculturable land	2,228	5.02
(c) Total	4,315	9.73
Other uncultivated land excluding fallow land		
(a) Permanent pastures	3,279	7.39
(b) Land under miscellaneous, tree crops and groves not included in sown area	79	0.18
(c) Cultivable waste land	2,285	5.15
(d) Total	5,643	12.72
Fallow land		
(a) Fallow lands other than current fallows	890	2.00
(b) Current fallows	737	1.66
(c) Total	1,627	3.66
Net area sown	18,163	40.95
Total cropped area	20,001	..
Area sown more than once	1,838	..
Net irrigated area	1,309	2.95
Gross irrigated area	1,363	3.07
Percentage of net irrigated area to net cultivated area		7.21
Percentage of gross irrigated area to gross cultivated area		6.81

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, New Delhi.

The major part of the rainfall occurs in the period from June to October due to the south-west monsoon while the winter rains contribute 12 to 15 per cent.

Land Use and Cropping Pattern

9.6. Agriculture is the most important occupation of the people. Table 9.1 gives the land utilisation statistics for the State for the year 1968-69.

9.7 Agriculture in Madhya Pradesh is largely devoted to the cultivation of food grains. During 1968-69, out of a gross cultivated area of 20.00 million hectares, 16.32 million hectares (81.6%) were under food grains. Table 9.2 shows the areas under different crops during 1968-69.

Table 9.2

Area under Different Crops—Madhya Pradesh

Crop	Area (thousand hectares)	Percentage to total cropped area
1	2	3
Rice	4,312	21.56
Jowar	2,374	11.87
Wheat	3,011	15.06
Bajra, maize, barley and other millets	2,709	13.54
Total cereals & millets	12,406	62.03
Gram	1,495	7.42
Arhar and other pulses	2,416	12.13
Total pulses	3,911	19.55
Total food grains	16,317	81.58
Other food crops	284	1.42
Total food crops	16,601	83.00
Groundnut	496	2.48
Sesamum	387	1.94
Other oilseeds	955	4.77
Total oilseeds	1,838	9.19
Cotton	688	3.44
Fodder crops	805	4.02
Other crops	69	0.35
Total cropped area	20,001	100.00

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, New Delhi.

Table 9.2 shows that nearly 82 per cent of the total cultivated area in 1968-69 was under food grains. The main food crops were rice (21.56%), jowar (11.87%), wheat (15.06%), maize and other millets (13.54%), accounting for 62 per cent of the total cropped area. Pulses contributed 19.55 per cent of the total cropped area. Among the non-food crops, oilseeds (9.19%), cotton (3.44%) are the most important. The area under sugarcane, fruits and vegetables is insignificant, and only 1.42 per cent of the total cropped area was under these crops.

9.8 The average yield of important crops both under irrigated and unirrigated conditions is shown in the following table:

Table 9.3

Average Yield of Important Crops—Madhya Pradesh

(Kg. per hectare)

Crop	1960-61		1965-66		1968-69	
	I.	N.I.	I.	N.I.	I.	N.I.
1	2	3	4	5	6	7
Rice	1,080	810	810	370	1,160	630
Jowar	..	740	..	640	..	570
Maize	1,340	1,140	..	820	970	540
Wheat	1,110	640	880	500	1,040	620
Gram	980	580	810	500	690	480
Groundnut	..	680	720	440	770	460
Cotton	380	370	400	190	410	250

Source: State's Replies to Irrigation Commission Questionnaire.

Note: (1) Average yield has been arrived at as a result of crop cutting experiments by random sampling method.

(2) I means 'irrigated' and N.I. means 'non-irrigated.'

Surface Water Resources

9.9 Table 9.4 shows the salient features of the major rivers in Madhya Pradesh.

All the rivers in the State are rainfed and the major run-off is during the monsoons. Of the total flow in the rivers, 80 to 90 per cent is in the monsoon period from June to October. The flow during January to May

is hardly 5 per cent of the annual yield. Table 9.5 shows the percentage of yields in some major rivers during different parts of the year.

Table 9.4

Salient Features of the Major Rivers in Madhya Pradesh

S. No.	Name of river	Drainage area within Madhya Pradesh (sq. km.)	Average annual run-off (m.cu.m.)	Remarks
1	2	3	4	5
1.	*YAMUNA RIVER BASIN*			
	Chambal	22,600	4,441	The average flow is up to the Gandhisagar Dam.
	Parvati Sindh Betwa	90,662	25,656	The average flow has been derived from the average inflow worked out for certain projects.
	Ken	23,490	9,374	The average flow is derived from the data for the Gangau Dam.
2.	*GANGA BASIN*			
	Tons	14,170	6,537	Observed flow at Purwa site.
	Son Rihand	42,436	21,833	Average flow derived from Chorhut discharge site.
3.	*MAHANADI*	77,192	39,471	Estimated average flow.
4.	*GODAVARI BASIN*			
	Indravati Wainganga Sabari Pench	65,265	34,537	-do-
5.	*NARMADA*	85,946	37,004	Observed flow at Garudeshwar.
6.	*TAPI*	9,496	1,974	Observed flow at Burhanpur.
7.	*MAHI AND OTHER BASINS*	8,229	2,467	Estimated flow
	Total:		183,294	

Source: State's Replies to Irrigation Commission Questionnaire.

Table 9.5

Percentage of the Yields in Some Major Rivers during Different Parts of the Year

S. No.	Name of river	Percentage of yield		
		June-Sept.	Oct.-Dec.	Jan.-May
1	2	3	4	5
1.	*NARMADA*			
	(a) at Jamtara	90.38	8.27	1.35
	(b) at Mortakka	85.08	12.16	2.76
2.	*GANGA* (Son)			
	(i) Churhat (Tons)	88.25	8.83	2.92
	(ii) Purwa	70.75	23.73	5.52
3.	*TAPI*			
	at Burhanpur	89.41	9.67	0.92
4.	*GODAVARI*			
	at Bhimagarh	86.28	11.34	2.38

Source: State's Replies to Irrigation Commission Questionnaire.

Hydrological Observations

Prior to 1957, there were only a few stations in the State for recording observations of river flows. However, records of the daily inflow and outflow of some important tanks (like the Murumsilli Reservoir, the Tandula Reservoir, the Kharung and Maniari Tanks in the Mahanadi basin, the Harsi Dam, the Kaketo Dam and the Tigra Dam in the Yamuna basin, the Jamnia Tank, the Bori Tank, the Ari Tank in the Godavari basin) had been maintained almost from the time of their completion. These records help in the study of the hydrology of streams in the region.

Systematic gauge and discharge observations on the Narmada (which has nearly 87 per cent of its total catchment area of 98,795 sq. km. in Madhya Pradesh) started only in the year 1947. The Central Water and Power Commission took up investigations in that year for formulating flood control measures and for an assessment of the water resources which could be used for the development of irrigation, hydro-power etc. For the collection of data, eleven discharge stations—six on the main river and five on the tributaries—were established. The main river was gauged at Mandla Bargi, Jamtara Railway bridge, Punasa, the Mortakka Railway bridge and at Garudeshwar in Gujarat. The sites on the tributaries include Tawa

at the Tawa dam site, the river Burhner at Khorakhada and Mohgaon, the river Barna at Bari and the river Dudhi at the Dudhi Railway bridge. The work of recording gauge and discharge observations at all the above stations was handed over to the States concerned in 1953. Madhya Pradesh continued to make observations only at Jamtara, and at Mortakka on the main river, while the observations at Garudeshwar are being continued by the Gujarat State.

Observations are also being done in other river basins of the State. The following table shows the details regarding number of gauge and discharge stations in different river basins in the State.

Table 9.6

Gauge and Discharge Stations in Different River Basins—Madhya Pradesh

S. No.	Name of river basin	No. of stations on the main river			No. of stations on tributaries			No. of stations on sub-tributaries			Total		
		G.	GD.	GDS.	G.	GD.	GDS.	G.	GD.	GDS.	G.	GD.	GDS.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Godavari	—	—	—	5	5	—	29	6	1	34	11	1
2.	Yamuna	—	—	—	8	6	2	26	6	4	34	12	6
3.	Ganga	—	—	—	3	3	4	16	8	3	19	11	7
4.	Narmada	4	5	3	24	6	3	8	1	1	36	12	7
5.	Mahanadi	3	2	—	9	5	2	2	6	—	14	13	2
6.	Tapi	1	2	—	—	—	—	—	—	—	1	2	—
7.	Mahi	—	2	—	1	—	—	3	—	—	4	2	—

Source: State's Replies to Irrigation Commission Questionnaire.
Note: G — Gauge Station
GD — Gauge and Discharge Station
GDS — Gauge, Discharge and Silt Observation Station.

9.10 To harness the water resources of the State, the Government appointed a Committee in 1965, called the Madhya Pradesh Water Resources Development Committee, whose main terms of reference were:

(i) to prepare in outline, an adequate and realistic plan for the development of the water resources of the State with particular reference to the development of irrigation as a means of increasing agricultural production;

(ii) to supervise the preparation of Master Plans for different river systems on lines similar to those followed in the preparation of the master plan for the Narmada and to advise Government on the

development works to be undertaken in accordance with the master plans; and

(iii) to examine the adequacy of the present organisation of the Irrigation Department in the State and to recommend improvements for ensuring faster development.

The Committee, after examining all the data available, reported in its 'First Report' published in 1969 that—

(i) it was not possible at that stage to prepare a realistic plan for the development of the water resources of the State as the basic data were not available;

(ii) practically nothing had so far been done to work out the potential of the river basins in the State except, perhaps, for the Narmada for which river a master plan had been prepared for submission to the Khosla Committee; and

(iii) the present organisation of the Irrigation Department in the State was inadequate to tackle the problem of developing irrigation.

The Committee had recommended that the following steps should be taken, immediately for the collection, compilation and study of the basic data necessary for water resources development. For this purpose, it had recommended:

(i) setting up a chain of river-gauging stations on each river system for measuring daily river flows;

(ii) setting up for the whole State, a system of sub-soil water level observations to be made twice a year, before and after the monsoons;

(iii) demarcation of the areas likely to be irrigated; and

(iv) reorganising and strengthening the Irrigation Department to cope with the tasks outlined above.

The Committee felt that the preparation of an adequate plan for the whole State would take a considerable time. As it was not possible to hold up development till the plan was prepared, they recommended that steps should be taken:—

(i) to prepare, on the basis of such details as were available, master plans (in outline) for each basin or sub-basin on the lines of the master plan prepared for the development of the Narmada basin; and

(ii) to define, by preliminary field investigations, the scope and feasibility of important projects included in the master plan.

The Committee recommended that the projects already selected for inclusion in the plan, or those which may be selected later, should conform to the general framework of the master plan.

Irrigation Potential from Surface Sources

9.11 The available estimates place the irrigation potential of Madhya

Pradesh from all surface sources at 6.44 million of which 5.63 million hectares could be realised from major and medium works and 0.81 million hectares from minor works.

Ground Water

9.12 The Geological Survey of India has carried out regional geo-hydrological investigations involving, primarily, a study of the occurrence, form and scope of ground water in relation to different geological conditions. Field studies have been carried out in Madhya Pradesh for the following areas:

(i) Alluvial tracts/river basins or valleys.
(ii) Consolidated or hard rocks.
(iii) Waterlogged areas.

Alluvial Tracts

Narmada Valley: An area of about 12,950 sq. km. of alluvial deposits in parts of Bhopal, Hoshangabad and Jabalpur districts on either side of the Narmada river, was studied in detail. Exploratory drilling of 44 bore holes down to a maximum depth of 450 m. was carried out. This study led to the delineation of five areas viz. Pagdhal, Pamerkheda-Babai, Kapuria-Kalan-Bareli Tonga, and Piparia-Sainkheda-Godarwara, Shahpura-Bheraghat, which were considered to be suitable for the development of ground water by means of tubewells. In all, an area of about 227,000 hectares to the south, and an area of about 89,000 hectares to the north of the river Narmada were found to hold great promise for large-scale development by means of tubewells, which could be sunk to a depth of 90 m. to yield over 0.1 million litres of water per hour. The chemical quality of the ground water in the explored area was found to be suitable for irrigation.

Tapi Valley: The Tapi valley was explored for ground water by means of 18 exploratory bore holes down to bed rock (basalt) with depths varying from 22.8 to 242 m. below the surface. The exploration delineated three areas suitable for ground water development by means of tubewells (i) the Rajora area (ii) the Rava area and (iii) the Karpavali area.

Favourable conditions for large-scale ground water development do not appear to exist in the rest of the Tapi valley. The quality of ground water in the explored area is suitable for irrigation.

Chambal Valley: Geo-hydrological studies were carried out in an area of 5,700 sq. km. lying in parts of the Bhind, Morena and Gwalior districts of Madhya Pradesh. The area underlain by alluvium resting upon the rocks of the Gwalior district is less than 30 m. thick, in Bhind district less than

60 m. thick and in Morena district generally less than 50 m. thick. Open wells in these areas draw ground water from shallow aquifers formed by yellow salty clay and kankar beds. In the alluvial tract of the Morena and Bhind districts, sand, gravel and kankar zones contain ground water under confined conditions. In the Gwalior district, ground water occurs in confined conditions in beds composed of boulders, pebbles, gravel and kankar. In parts of these areas in Chambal valley, progressive waterlogging is taking place. Areas already waterlogged and some others which are likely to become waterlogged have been demarcated.

Consolidated or Hard Rocks

Ground water studies in the rock groups, equivalent to the Dharwars of the Bailadila ranges in Bastar district, indicate that the development of ground water in any considerable quantity even by open wells is not possible.

Waterlogged Areas

Waterlogged conditions in the Chambal command area falling in parts of Bhind, Gwalior and Morena districts of Madhya Pradesh have been studied. About 30 sq. km. in the Tigara command and a small area in Bhind district are already waterlogged. About 870 sq.km. in Bhind district and 850 sq. km. in Morena district are likely to get waterlogged when full irrigation is introduced. The causes of waterlogging are attributed to (i) the presence of impermeable clay soil on the surface (ii) seepage from the flowing canals (iii) poor drainage conditions and (iv) obliteration of natural water courses formerly draining the area.

Irrigation Potential from Ground Water Sources

9.13 The potential from ground water sources in the State has been estimated at 1.62 million hectares.

The overall irrigation potential from all sources, surface as well as ground water, is thus of the order of 8.1 million hectares.

Development of Irrigation—Present Stage

9.14 Prior to 1951, irrigation had made very little headway in the areas which now constitute Madhya Pradesh. Only the Chattisgarh and Gwalior regions had any irrigation facilities worth the name. In pursuance of the recommendations of the First Irrigation Commission, an Irrigation Circle was set up in the Mahakosal region for undertaking the construction of

State irrigation works to serve as an insurance against famine. By the end of 1928, an amount of Rs. 64 million had been spent on various irrigation works in the State. In view of the slow development of irrigation, the State Government appointed a Committee in 1927 which, inter-alia, recommended that until the Government was satisfied with the development of, and the returns from, works already constructed, no new works should be undertaken on any appreciable scale. As a result of the recommendations of the Committee all new construction was prohibited and the Irrigation Branch was abolished. By 1952, 22 big and 74 small works were in operation, capable of irrigating an area of about 0.33 million hectares. The major works completed were the Mahanadi Canal System, the Tandula Reservoir, the Kharung and Maniari Reservoirs, the Tigra Dam, the Bhind Canal etc. A total area of 0.89 million hectares were irrigated from all sources. The details were as follows:

Table 9.7

Source-wise Irrigation—1952

(*Thousand hectares*)

S. No.	Source	Area irrigated
1	2	3
1.	Govt. works (canals, tanks and tubewells)	354
2.	Private tanks including ex-malguzari	235
3.	Wells including private tubewells	249
4.	Miscellaneous	52
	Total:	890

During the Plan periods, the State has undertaken a number of major and medium irrigation schemes. As a result of all these efforts, the irrigated area increased to 1.08 million hectares by 1964-65 and during the year 1968-69 (the latest year for which compiled data are available), it was 1.35 million hectares (gross). The total sown area in the latter year was 20.00 million hectares, that is, the gross irrigated area constituted only 6.8 per cent of the total sown area compared to the national average of 20 per cent.

The expenditure of Rs. 1,190 million incurred by the State on schemes of irrigation development during the 18 years since 1951, has created a total potential of about 0.79 million hectares.

Important Projects and Their Salient Features

9.15 *The Chambal Project* is by far the biggest taken up by Madhya

Pradesh and is a joint venture with Rajasthan. The Chambal, a major right bank tributary of the Yamuna, rises near Mhow in the Vindhyas and drains its northern slopes. The river flows for the first 274 km. in Madhya Pradesh and for the next 153 km. in Rajasthan. It forms the boundary between Madhya Pradesh and Rajasthan for a distance of 241 km. and between Madhya Pradesh and Uttar Pradesh for a length of 105 km. After flowing for another 40 km. in Uttar Pradesh, the Chambal joins the Yamuna.

The Chambal Project consists of three storage reservoirs viz. Gandhi Sagar (completed in 1960), Rana Pratap Sagar (completed in 1970), Jawahar Sagar (under construction), and a barrage at Kota from where the irrigation canals take off to irrigate 283,000 hectares each in Madhya Pradesh and Rajasthan. The Gandhi Sagar Dam is in Madhya Pradesh while the Rana Pratap Sagar, the Jawahar Sagar and the Kota Barrage are in Rajasthan.

The Gandhi Sagar Dam, on which work started during the First Five Year Plan, was the first of the three dams taken up for construction as a part of the Chambal valley development. The river Chambal drains an area of 22,530 sq.km. at the dam site. The Gandhi Sagar Dam which has a maximum height of 64 m. and a length of 513 m. has a live storage capacity of 6,920 m.cu.m. and is one of the biggest dams in the country. Five power units of 23,000 KW each have been installed at the dam.

The Rana Pratap Sagar was the next reservoir on the Chambal river to to be completed (1970). It is located 56 km. downstream of the Gandhi Sagar Dam and drains an additional catchment area of 2,330 sq.km. (total C.A. 24,860 sq.km.). The maximum height of the dam is 54 m. and the length is 1,143 m. The reservoir has a live storage capacity of 1,567 m.cu.m. Four units of 43,000 KW each have been installed at the dam.

The Jawahar Sagar which is under construction is the third reservoir on the Chambal, situated 22 km. downstream of the Rana Pratap Sagar. At this site, the Chambal drains a further area of 1,940 sq.km. (total catchment area 26,810 sq.km.). It is a power project and will have an installed capacity of 3 units of 33,000 KW each.

The lowest of the works in the Chambal valley development scheme is the Kota Barrage, which provides irrigation. The work on the barrage was taken up simultaneously with the Gandhi Sagar Dam and was completed in 1960. The Left Bank Canal irrigates land only in Rajasthan while the Right Bank Canal irrigates land both in Rajasthan and in Madhya Pradesh. Irrigation from the project started in 1960. However, the full development of 567,000 hectares as envisaged in the project is expected to be achieved by the end of Fourth Plan (1974). On completion, 283,000 hectares in Madhya Pradesh and an equal extent of area in Rajasthan will be benefited by the project.

Though the Gandhi Sagar Dam and Kota Barrage were completed in

1960 and canal irrigation in Madhya Pradesh started immediately thereafter, the utilisation so far has been less than 25 per cent of the ultimate potential of 284,000 hectares. Irrigation projects of this size are built at enormous cost to the State and if the potential created is not utilised it is a waste of national wealth. We recommend that the State should probe into the causes of delay in the utilisation of the irrigation potential and take appropriate steps to remedy the situation.

The *Tawa Project* is the first major scheme taken up by Madhya Pradesh to harness the waters of the Narmada basin. The Tawa is a major left bank tributary of the Narmada having a total catchment area of 6,330 sq.km. The Tawa Project, as envisaged, consists of a composite dam of a maximum height of 58 m. and a length of 1,629 m. The reservoir will have a live storage capacity of 2,086 m.cu.m. and will provide irrigation to 304,000 hectares. The work on the project started in 1962 and it is expected to be completed during the Fifth Plan.

The work on the Tawa Project, though sanctioned during the Second Five Year Plan (1956-61), started only in 1962. The progress achieved on the project so far is far from impressive. We were informed that the project may be completed only during the Fifth Plan (1974-79). Inordinate delay in the completion of the project has not only postponed the benefits of irrigation to the farmers but has considerably inflated costs. We recommend that the State Government should examine, thoroughly, the reasons for the inordinate delay, and take appropriate steps to ensure the speedy completion of the project. Such a probe would be helpful not only to this project, but its findings would serve to avoid the occurrence of delays in future projects.

The *Barna Project* in the Narmada basin envisages the construction of a storage reservoir across the Barna—a right bank tributary of the Narmada. The project, on which work started in 1960, consists of an earthen dam 396 m. long with a maximum height of 48 m. The live storage capacity of the reservoir will be 407 m.cu.m. The project will benefit 60,000 hectares and is expected to be completed during the Fourth Plan.

The *Hasdeo Project* which was taken up for supplying water for cooling purposes at the Korba Thermal Power Station (Bilaspur district) consists of a barrage across the river Hasdeo, a tributary of the Mahanadi, and a left bank canal 3.5 km. long. The barrage and the canal were completed by June 1967. The right bank canal which was taken up in 1969 takes off from the barrage to irrigate 47,000 hectares. The scheme is expected to be completed in 1972.

The State has also undertaken a number of medium irrigation projects and by 1969, twenty-six such medium schemes had been completed to provide irrigation to nearly 81,000 hectares. Appendix 9.1 shows the salient features of all the projects (irrigating 4,047 hectares and more)

completed by March 1969, and also the details of projects which are under construction and have been continued after March 1969.

9.16 The average annual yield from the rivers in Madhya Pradesh has been estimated at 185,000 m.cu.m. It is stated in the Fourth Plan document of the State that the present utilisation is 370 m.cu.m. However, an assessment of the utilisable quantity of water out of the estimated availability is yet to be made.

Minor Irrigation

9.17 Prior to the commencement of the First Five Year Plan in 1951, a total area of 0.43 million hectares was being irrigated by minor irrigation schemes—0.18 million hectares by surface water and 0.25 million hectares by ground water. By 1964-65, the area under minor irrigation increased to 0.5 million hectares—0.13 million hectares by surface water and the remaining 0.37 million hectares by ground water—making the necessary allowances for the depreciation of the existing works.

The net area irrigated from all sources at the end of 1968-69 stood at 1.31 million hectares. The area under different sources of irrigation was as follows:

Table 9.8

Source-wise Irrigation—1968-69

(*Thousand hectares*)

Source	Area irrigated
1	2
Government canals	623
Private canals	2
Tanks	177
Wells (including tubewells)	449
Other sources	58
Total:	1309

Ayacut Development

9.18 The development of irrigation under the Chambal Project has not been very encouraging. Even ten years after the commencement of irrigation, hardly 25 per cent of the ultimate benefits have been realised. The

State Government has now drawn up a detailed scheme for ayacut development in the Tawa Project so that no delay occurs in the utilisation of the irrigation potential when it has been created. The following are the main ingredients of the scheme:

(a) Agriculture
  (i) Consolidation of holdings, land-shaping and drainage.
  (ii) Extension
  (iii) Research
(b) Communications
(c) Veterinary and fisheries
(d) Agro-industries
(e) Warehousing and marketing
(f) Construction of water courses.

In Madhya Pradesh, consolidation of holdings is voluntary, but it can be enforced in a village if 66 per cent of the population is agreeable to the consolidation of holdings. Land-shaping is proposed to be done simultaneously with consolidation.

It is proposed to give priority to the road build-up programme in the command area for handling the increased agricultural production. The details of the proposed road net-work have been worked out.

It is expected that land-shaping and land preparation in the Tawa command will be done mechanically. However, to enable the farmers to do the work by using animal power also, it has been proposed to advance loans for the purchase of bullocks.

A programme for the agro-industrial development of the command area has been prepared. Storage facilities for the agricultural produce, and agricultural inputs like seeds, fertilisers etc. will be provided by different agencies like (i) Government (ii) Warehousing Corporation (iii) Co-operative Societies and (iv) Individual traders.

Future Possibilities of Irrigation

9.19 The total cropped area in Madhya Pradesh during the year 1968-69 was 20.00 million hectares, of which barely 6.8 per cent (1.36 million hectares) was irrigated. The remaining 93.2 per cent depended on rainfall. Though the total rainfall averages 760 to 1520 mm. per year and appears to be sufficient for raising one good crop, it is confined to four months—June to September. It does not cover the full crop season. Quite often, it is unevenly distributed and fails just when it is needed most by the crops. Agricultural production in the State can be substantially improved by providing better irrigation facilities.

The Madhya Pradesh Government took up a number of major irrigation

schemes during the three Five Year Plans. The Chambal Project to benefit 283,000 hectares, the Tawa and Barna Projects to benefit 304,000 and 66,000 hectares respectively, and the Hasdeo Right Bank Canal to benefit, 47,000 hectares, are all expected to be completed during the Fourth Plan. In the case of the Tawa and Barna Projects, there may be some spill-over into the Fifth Plan. Some medium schemes now in hand will also be completed in the Fourth Plan period.

9.20 The State proposes to take up the following new schemes during the Fourth Plan:

The *Bansagar Project* envisages the construction of a dam on the Son river to provide irrigation to 54,000 hectares in the Rewa and Satna districts and also to generate 250 MW of power at 60 per cent load factor. The project is proposed to be completed by the end of the Fifth Plan. However, some irrigation will be possible earlier.

The *Bargi Project* was originally envisaged by the Central Water & Power Commission to irrigate 215,000 hectares. The State is examining the possibility of increasing irrigation in the valley and proposes to complete a substantial portion of the work during the Fourth Plan, so that benefits may start accruing during the Fifth Plan.

The *Halali Project* envisages the construction of a dam across the Betwa, a tributary of the Yamuna, to provide irrigation to 39,000 hectares. The State proposes to complete the project during the Fourth Plan.

The *Satiara Project* envisages the construction of a dam across the Mahanadi river in the Raipur district, upstream of the existing Rudri Weir. In addition to supplying water for the Bhilai Steel Plant, the project will provide irrigation to 57,000 hectares—41,000 hectares under the Mahanadi Canal System and 16,000 hectares under the Tandula System.

Medium Projects

Twenty-five medium schemes for irrigation are proposed to be taken up during the Fourth Plan, of which 21 are expected to be completed during that Plan.

The following table gives the salient features of the major and medium projects proposed to be undertaken during the Fourth Plan:

Minor Irrigation

9.21 The State proposes to bring an additional area of 519,000 hectares (130,000 hectares by the PWD and 389,000 hectares by the Agricultural Department) under minor irrigation schemes.

Table 9.9

Proposed Projects during Fourth Plan—Salient Features

Name of Project	Location (Distt.)	Estimated cost (Rs. million)	Benefits (thousand hectares)	Likely date of start	Estimated date of completion
1	2	3	4	5	6
MAJOR PROJECTS					
Bansagar (Son)	Rewa/Satna	9500.00 +250 MW Power @ 60% LF	133.5	NA	V Plan
Bargi (Narmada)	Jabalpur	NA	NA	NA	NA
Halali (Betwa)	Vidisha	596.60	38.8	NA	V Plan
Satiara (Mahanadi)	Raipur	3097.00	56.7	NA	NA
MEDIUM PROJECTS					
Jamni RBC	Tikamgarh				
Rangwan HLC	Chatarpur				
Dumaria	Durg				
Jhirigiri	Jabalpur				
Mayana	Bastar				
Phytka	Raigarh				
Kunwarpur	Surguja				
Johilla	Shahdol				
Bichhia	Mandla				
Bangor	Seoni				
Kishenpur	Indore				
Paronch	Shivpuri				
Pipaliakumar	Shajapur		Not available		
Khasiwari	Rewa				
Upper Ken	Panna				
Chandera	Betul				
Sakalda	Dhar				
Majgoan	Mandla				
Parna	Damoh				
Pairi	Raipur				
Umarala	Shahdol				
Kerwan	Sehore				
Barunadi	Bastar				
Sukta	East Nimar				

Source: Draft—Fourth Five Year Plan 1969-74, Madhya Pradesh—pages 125-128.
Note: NA—Not available

As a result of the implementation of the above mentioned major and medium schemes and the minor irrigation programme proposed for the

Fourth Plan, an additional irrigation potential of 1.17 million hectares is expected to be created, as detailed below:

	Thousand hectares
Major Schemes	
Tawa	304
Barna	66
Chambal	20
Bandar Canal	11
New schemes (Halali)	36
Medium Schemes	
(a) Continuing	138
(b) New	79
Minor Irrigation	
(a) PWD Sector	130
(b) Agriculture Sector	389
Total	1173

9.22 The total irrigation potential in Madhya Pradesh under major and medium projects has been estimated to be 5.63 million hectares, and that under minor irrigation 2.43 million hectares (0.81 million hectares from surface water resources and 1.62 million hectares from ground water resources).

Floods and Waterlogging

9.23 There is no serious flood problem in the State.

9.24 The problem of waterlogging exists only in the command of the Chambal Project. Part of the command under this project had been receiving irrigation from the Bhind Canal System for over four decades. After nearly seven years of irrigation from the Chambal canals, the water-table in the upper reaches has risen considerably and in some areas, has come up to within 1.5 m of the surface and is threatening waterlogging. The State Government has formulated preventive measures to deal with this problem. Some of the measures proposed are:

(i) providing seepage drains along canals so as to lead the seepage water from the canals into the main drainage;

(ii) providing drains leading to nallas and remodelling the nallas and their outlets.

Criteria for Sanctioning of Projects

9.25 At present major and medium irrigation projects in the State are sanctioned on the basis of the financial return as laid down by the Government. However, in accordance with the policy of the Government of India, major and medium projects are also sanctioned if the benefit-cost ratio is 1.5 or more.

Minor irrigation works are sanctioned depending upon the cost per acre of the individual project. Different criteria are adopted for area with an unfavourable topography. The details are as below:-

Works	Cost per acre	
	Districts with difficult topography	other districts
(1) New minor works	Rs. 1200-1500	Rs. 1000-1200
(2) Improvement to old tanks	Rs. 800-1000	Rs. 800-1000
(3) Diversion works	Rs. 400-600	Rs. 400-600

The same yardstick is applied in the sanctioning of projects in the drought-affected areas.

Betterment Levy

9.26 According to Section 58-C of the Betterment Levy Act passed in Madhya Pradesh in 1968, a betterment contribution is leviable from such date as the State Government may, by notification, appoint, provided that this date is not earlier than three years from the commencement of the operation of a new canal. Under the Act, the betterment charges are leviable on every permanent holder of land, whose land is situated within the command area, at the following rates:

(a) Rs. 140/- per acre payable in one lump sum, or
(b) Rs. 224/-per acre payable consecutively for twenty years, excluding the years in which the recovery may be postponed by the State Government at the following rates:
  (i) Rs. 8/- per acre per year for the first five years
  (ii) Rs. 12/- per acre per year for the next fourteen years
  (iii) Rs. 16/- per acre for the twentieth year.

So far no betterment levy has been recovered.

Water Rates

9.27 Water rates and land revenue are separately assessed in Madhya Pradesh, except in certain cases of irrigation by tanks in the northern districts of the State where water rates and land revenue are amalgamated. The water rates for different crops are as follows:

Table 9.10

Water Rates of Different Crops

Name of crop	Water rate (Rs.) per acre per crop	
	Long term arrangements	Demand rate
1	2	3
Rice	8.00	12.00
Wheat	—	4.00
Sugarcane	—	30.00 (for complete irrigation of crop) 12.00 (for sparsely irrigated)
Sweet potatoes, groundnut (kharif) and turmeric	—	6.00
Cotton (kharif) Singhara	—	8.00
Garden crops such as chillies, vegetables, potato, water melon, orchard, rubber plant etc.	—	20.00
Poppy	—	9.00
Tobacco (kharif)	—	9.00
Castor (kharif), other jowar, thatching grass, mung, urad, bajra, kodo, sawan, sun-flower, soyabeans and other minor crops	—	4.00
Sunhemp, cloves, berseem and lucerne and other fodder crops	—	15.00
Green manuring crops (Sann, dhancha etc.)	—	2.00
Groundnut (rabi), cotton (rabi), summer jowar, winter rice, plants mung (rabi), sunflower (rabi), tobacco (rabi)	—	Rs. 8.00 (The rate for tobacco in Madhya Bharat region is Rs. 9.37 per acre.)
Castor (rabi), oats, mustard, bajra, peas soyabean (rabi), barley	—	Rs. 6.00 (The rate for barley in Madhya Bharat region is Rs. 7.50 per acre.)

Table 9.10—Contd.

Name of crop	Water rate (Rs.) per acre per crop	
	Long term arrangements	Demand rate
1	2	3
Grams	—	Rs. 3.00 (Rate in Bhopal region is Rs. 10/- per acre.)
Barley (rabi)	—	Rs. 5.00 (The rate in Madhya Bharat region is Rs. 7.50 per acre.)
Pan, plantains, mulberry plants (perennial)	—	Rs. 20.00
Preparing land for cultivation for ploughing only	—	Rs. 2.00 (From 1st July to 31st December.)
		Rs. 4.00 (From 1st January to 30th June)
Note (1) Water rate for lift irrigation by Government	—	Double the flow rate indicated above.
(2) Water rate for lifting water through private agencies by mechanical means.	—	Half the flow rate.
(3) Water rate for lift irrigation by mote or other manual devices.	—	One-fourth of the flow rates indicated above.
(4) Extra rate for applications received after the fixed date.	—	10% extra over rates above and in Madhya Bharat region it will be double the water rate.

The water rates for works situated in the Scheduled areas of tribal districts and for cultivators of the Scheduled Castes and Scheduled Tribes are as follows:

First year — No charge
Second year — One-fourth of the flow rates
3rd year to 10th year — One-half of the flow rate.

The position will be reviewed after 10 years. Other cultivators of the area will pay the normal rates.

Water rates for minor irrigation works with permanently settled rates (in the erstwhile Madhya Bharat, Vindhya Pradesh and Bhopal regions) are as follows:

When an old scheme is restored and the land assessed as Adan or Abi, ryots are exempted from the payment of water rates. If, however, the former is lower than the canal water rates, cultivators have to pay the difference i.e. the 'Adan' or 'Abi' rate will be treated as a rebate.

Water cess at the rate of Rs. 2.50 per acre of irrigable area for irrigation under canal systems and Re. 1/- per acre of area under small submerging tanks, ex-malguzari tanks, regulators, pick-up weirs and bhandaras is levied.

Tours, Inspections and Observations

9.28 We toured the State from the 1st to the 9th of November 1970, and were able to visit Mahakoshal and the Chhatisgarh and Vindhya Pradesh areas. We saw the sites of a number of irrigation works, including eight major works. We were accompanied, for a part of our tour, by Km. Vimla Verma, Minister for Power of the State Government. We held detailed discussions with some Members of Parliament, Members of the Legislative Assembly, Chief Engineers, officials and progressive farmers, and were able to gather a fairly comprehensive picture of the irrigation problems of Madhya Pradesh. Our observations and impressions of the tour are briefly indicated below:

Tawa and Barna Projects

9.29 The Tawa Project is one of the two major projects based on the Narmada, which is the least exploited river in the State. Both the Tawa and Barna Projects were sanctioned during the Second Plan period, but progress in these projects has been slow. It appears that the State Government itself feels that, although it is likely that the Barna Project will be completed before the end of the Fourth Plan (1974), the Tawa Project will not be completed till some time in the Fifth Plan. When we visited the Tawa Project, we found that the progress of work was very slow, and that the masonry work had hardly reached above bed level. It was explained to us that the work in the river portion of the dam had been delayed because of foundation trouble. It appears that, during the course of construction, it was found that the foundations were defective, and this caused a major set-back to the progress of the scheme. The State Government has now set up a high-level committee of engineers and geologists to study the problem, and to advise the project authorities with regard to the best design for the foundations. We would venture to say, without

prejudice to the findings of this committee, that the present difficulties could, perhaps, have been largely avoided had the investigations, particularly with regard to the foundations, been more thorough. We are of the opinion that investigations, both on the surface and underground, should be a continuous process, and time spent on these investigations is always well spent. The present policy of taking up serious investigations only on such projects as are likely to be taken up in the near future, should be revised. We would recommend that systematic and continuous investigations of all likely projects in a river basin should be taken up in some reasonable order of priority, so that, when the time comes for a project to be implemented, construction work will be based on thorough investigations which will obviate unforeseen delays to a very large extent.

9.30 We paid a visit to the Designs Organisation of the State at Raipur. We regret to record that we were not particularly impressed with it. The workers appeared to have a grievance about their conditions of service. We cannot overemphasise the importance of having a well-manned and well-equipped designs organisation to make the fullest use of the data collected during investigations and to conduct studies relating to construction materials, hydraulic structures and river behaviour. We would like the State Government to examine the conditions prevailing in the designs unit at Raipur and to strengthen it suitably.

9.31 We were given to understand that the State proposes to set up a Board of Consultants for various major projects in the State. We commend this proposal and feel that such a Board would be useful for the Tawa Project.

Minor Irrigation

9.32 Wherever we went in the State, there was a demand for minor irrigation schemes, arising possibly because of the delay in the execution of major and medium projects. There was also a demand for the construction of small diversion works across streams to irrigate up to 40 hectares, and for action to maintain and repair tanks, which exist in very large numbers, but which, through lack of maintenance and repair, are going out of use. We would recommend that the repair and maintenance of tanks should be given very high priority particularly in areas such as Tikamgarh, where almost the entire irrigation is through wells and small tanks.

In Bastar district also, where there is little scope for big projects and where a small population is thinly spread over a large area, minor irrigation works, particularly small tanks, have the greatest utility. At Jabalpur representations were made to us asking for diversion schemes. In Raipur

district, we were told that as many as 90,000 wells could be dug. If double-cropping is to be successful, the well construction programme requires immediate attention.

Ground Water

9.33 Ground water surveys carried out in various areas reveal that the prospects in some areas are good. However, generally speaking, the prospects for successful tubewells are not bright. We were informed that a tubewell costing about Rs. 25,000/- gives an average yield of 10 to 15 thousand gallons per hour, and can command about 12 hectares. Emphasis should, therefore, be laid on increasing the number of dug wells and on repairing wells wherever this is possible.

Some exploration for ground water has been done in the Narmada valley, and a Tubewell Directorate has been formed to assist farmers to drill their own private tubewells. It is understood that about 730 such tubewells have been sunk in the last two years.

Ayacut Development

9.34 Although the experience of ayacut development in the Chambal Project has been far from happy, we noted with regret that even now there is inadequate appreciation of the importance of a comprehensive scheme for ayacut development. In the first volume of our Report, we have devoted a whole chapter to ayacut development and we would request the State Government to examine this question of developing the ayacuts of irrigation projects, in the light of the recommendations we have made.

Although the State Government has drawn up a programme of ayacut development in the Tawa command, no effective steps appear to have been taken to implement the programme. The benefits of irrigation from the Tawa Project are expected to be available from 1973 onwards, though the project itself may be completed in the Fifth Plan. There are, therefore, only two years left to implement the plan for ayacut development. We would recommend, therefore, that urgent steps be taken to set up a research station to determine the most suitable cropping pattern. Then levelling of land, the construction of ayacut roads and field channels, and the provision of market facilities should be done systematically, so that when irrigation begins in 1973, all the water released can be fully utilised, and the full benefit of the increased production can be availed of.

9.35 As far as we are aware, nowhere in the State have any field channels been constructed beyond the outlets. Irrigation, therefore, is being done from field to field and, for this reason, is wasteful. The problem of waste

will assume greater dimensions as soon as double-cropping is practised in various ayacuts which benefit from increased irrigation.

We would recommend that the question of constructing field channels to increase irrigation efficiency should be taken up seriously. The irrigation Panchayats, elected to discharge the responsibility for distributing water, for collecting revenue, and for settling disputes, are working fairly well, and the State Government should consider the possibility of giving these Panchayats the additional responsibility of constructing and maintaining field channels.

Irrigation Intensities

9.36 In our discussions with the State irrigation engineers we were given to understand that an irrigation intensity of 160 to 170 per cent is generally assumed in various projects. We feel that, even in well developed areas, these figures err on the optimistic side. Although, theoretically, cropping intensities of up to 200 per cent are possible, this theoretical ceiling has not been found to be a feasible target. There are several factors which affect intensity, including overlapping in the growing seasons, a shortage of animal power or of labour, the difficulty of completing the harvesting and processing of one crop in time to prepare the land for the succeeding crop, and the unsuitability of portions of the culturable command area for irrigation because of their topography. This last factor is of particular importance in Madhya Pradesh where, without extensive land-levelling and land-shaping, the optimum intensities of irrigation will be difficult to attain.

General

9.37 Among other points which were brought to our notice, we would like to draw the attention of the State Government to the persistent demand for liberalising conditions for giving power connections to energize pump-sets on tubewells. The State Electricity Board should examine the feasibility of liberalising the terms on which electricity is given.

9.38 There appears to be a genuine need to provide technical guidance to farmers in soil conservation methods and in the technique of lift irrigation. We would suggest that good use could, perhaps, be made of agricultural engineering graduates of the Jabalpur Agricultural University in this work.

9.39 We consider that irrigation engineers and agricultural extension workers need to be trained in water management. We understand that a training course in water management had been given for some time by the

J. N. Krishi Vidyalaya, Jabalpur, and that nearly 750 persons were put through this course. We were informed that the course had been discontinued because persons who had been trained could not find employment. We would strongly recommend that the State Government should review the position, and that steps should be taken not only to employ those who have been trained, but to revive the course, so that more workers can be trained in this extremely important branch of irrigation development.

9.40 We have identified 24 tehsils in 9 districts of the State as being drought affected (vide, Table 9.11). A number of irrigation schemes (vide, Table 9.12) have been proposed by the State Government for benefiting the drought-affected areas.

Table 9.11

Drought-affected Tehsils of Madhya Pradesh

I. *Jhabua District*

1. Jhabua
2. Thandla
3. Patlawad
4. Jobat
5. Alirajpur

II. *Dhar District*

6. Dhar
7. Badnawar
8. Sardarpur
9. Kukshi
10. Manawar
11. Tappa (Dharampuri)

III. *Dewas District*

12. Bagli
13. Khategaon

IV. *Ujjain District*

14. Khachrod
15. Ujjain
16. Tarna

V. *Khargaon District*

17. Rajpur
18. Harwani

VI. *Khandwa District*

19. Khandwa
20. Harsood

VII. *Datia District*

21. Datia

VIII. *Shajapur District*

22. Shajapur

IX. *Betul*

23. Betul
24. Bhainsadehi

Table 9.12

Irrigation Works Proposed by the State for the Drought Areas

Project	Drought districts benefited	Irrigation benefits (thousand hectares)
1	2	3
Narmada sagar	Khargaon & Khandwa	121.50
Sukta Project	Khandwa	16.81
Omkareshwar	Khargaon	13.00
Chandora Tank	Betul	4.10
Wardha	Betul	4.10
Bundala Tank	Betul	4.05
Amla	Betul	2.87
Sita Kund	Betul	2.18
Piplia Kumar	Shajapur	2.23
Sisodia Project	Shajapur	1.62
Sakalda	Dhar	4.04
Datuni River Project	Dewas	1.01
Bagdi River Project	Dewas	3.56
Lower Chandrakeshwar	Dewas	6.48
Padliya	Khargaon	0.75
Gadigaltar tank	Khargaon	12.30
Daljala Tank	Khargaon	20.80
Umar Khalia	Khargaon	11.48
Devikheda Tank	Ujjain	1.22
Quazikhedi Tank	Ujjain	1.05

CHAPTER X

MAHARASHTRA

The State of Maharashtra came into existence in its present form on May 1, 1960, on the bifurcation of the erstwhile Bombay State. It has an area of about 307,760 sq. km. Maharashtra shares a common boundary with Gujarat in the north-west, Madhya Pradesh in the north and east, and Andhra Pradesh and Mysore in the south.

Over 50 million people live in the 308 thousand sq. km. of Maharashtra. The density of population is 164 per sq. km. against the All-India average of 182 (excluding Jammu & Kashmir). About 69 per cent of the population live in rural areas and about 81 per cent of the working force is engaged in agriculture.

Physiography

10.2 The State can be divided into three natural regions: (*i*) The Konkan coast; (*ii*) The basins of the Krishna and Godavari; and (*iii*) The basin of the Tapi.

The Konkan coastal strip is separated from the rest of the State by the Sahyadri range which throws out numerous low spurs towards the east. Between these spurs, the valleys are drained by streams running from the east almost due west into the Arabian Sea.

The Konkan coast rises in altitude from almost sea level to about 90 m. except for the spurs mentioned above. This altitude has no marked effect on the temperature. Summers are warm and winters mild.

The basins of the Krishna and the Godavari separated from the coast by the Sahyadri range which really forms the precipitous western rim of the Deccan plateau, varies in height from about 610 m. in the west to about 152 m. in the east. Summer temperatures in the west are lower than in the east. The portion of the Godavari basin which lies within the State comprises the sub-basins of the Upper Godavari, the Pravara, the Purna, the Penganga, the Wardha, the Pranhita rivers, and a portion of the Manjra river. What may be called the main Godavari basin, comprising the Upper Godavari, the Pravara and the Purna sub-basins, lies between the Satmala range and the Balaghat range. It is narrow and hilly in its

upper reaches in the west, but broadens out and becomes flatter towards the east.

The Pranhita portion of the basin between the highlands bordering the Tapi basin and the Balaghat hills on the eastern boundary of the State, is relatively flat, except in the upper reaches towards the northern boundary. Further east, lies the Indravati sub-basin which is largely outside the boundaries of Maharashtra.

The Krishna basin includes the Bhima sub-basin which lies between the Mahadeo range and the Balaghat range. The Krishna basin proper, extends from the Mahadeo range to the southern boundary of the State, but much of it lies outside the State. With the exception of a strip spreading 40 to 56 km. from the western edge, the basin consists of the undulating plateau lands of the Deccan.

The basin of the Tapi lies between the Satpura range in the north, and the Satmala range in the south. It slopes from east to west at altitudes ranging between 152 and 610 m. In the east the valley is separated from the Wainganga basin by the Mahadeo hills running north to south. The Tapi valley is comparatively flat, broken only occasionally by spurs from the Satpuras.

Broadly speaking, the western part of the State, from the sea to a line about 65 km. to the east of the Sahyadri range, is hilly and undulating. Elsewhere, the undulation is less marked and depends very largely on how close the area is to one or other of the watersheds between the several basins and sub-basins.

Climate, Rainfall and Soils

10.3 The prevalent climate is of the tropical monsoon type, though the plateaus and hill areas of the State have lower temperatures and less humidity than the coastal strip.

Based on temperature, there are four climatic divisions in the State:

(i) the coastal districts of Konkan where seasonal variations are small, and the winter is mild and the climate humid.

(ii) The western portions of Nasik district and of the three districts of Poona, Satara and Kolhapur, where temperatures are low during the rains and winter, with low humidity, except during the monsoon months.

(iii) The eastern portions of the four districts mentioned above, and the districts of Osmanabad, Aurangabad, Bhir, Sholapur, Ahmednagar and Sangli are in the rain shadow of the Western Ghats and are chronically drought affected. Summer temperatures there are high and winter temperatures low.

(iv) Though the Vidarbha area and other areas not included in the above three regions get more rain, there is no marked difference in the pattern

of seasonal temperature, which is generally higher in summer and lower in winter compared to the third region. Here also, except during the monsoons, humidity is low.

10.4 Both the south-west and the north-east monsoons bring rain to Maharashtra. About 98 per cent of the rainfall in Ratnagiri district, and about 85 per cent in Sholapur district are brought by the south-west monsoon. The remaining districts get rain from the south-west monsoon in amounts ranging between these two figures. The balance of their rainfall comes from the north-east monsoon.

The average rainfall of the State is about 1,070 mm. though there are wide variations in precipitation. The heaviest precipitation during the south-west monsoon is on the Sahyadri rim of the plateau and in the Maval area to the east, up to a distance of 15-25 km. At the rim, the rainfall is very heavy, and exceeds 6,500 mm at places like Mahabaleshwar. It decreases rapidly westwards towards the coast, where it is about 3,200 mm in the south and about 2,000 mm in the north.

East of Sahyadri, the decrease is very marked and in areas 15 km from the range the precipitation drops to about 1,250 mm. A peculiar feature of the rainfall pattern is its incidence in a strip about 30-50 km wide east of Maval and running parallel to the Sahyadri range. In this strip the average rainfall is less than 650 mm, and at places below 500 mm. Further east it gradually increases, till it averages 1,250 mm in the most eastern districts.

Though the winter rains account for 5-6 per cent of the annual precipitation in the low rainfall belt, they are generally of little value. Large areas of the State suffer periodic crop failures because the monsoon fails or is erratic.

10.5 Geologically, major portion of the State is underlain by Deccan trap of volcanic origin and of more or less uniform composition. The main districts with trap formations are Ratnagiri, Kolhapur, Satara and Poona. The eastern districts are underlain by granites, gneisses and other mixed rock formations.

The physical and chemical characteristics of the major soil groups in the State are as follows :—

The alluvial soils of the west coast become impregnated with salts to a varying degree, according to their location with respect to the sea, and to the creeks which run out into the sea. As one proceeds away from the coast, the alluvial soils predominate.

The warm and humid climate and the forests have given rise to laterites and lateritic soils in the Deccan trap areas of south Kolaba, the major portion of Ratnagiri and in the eastern parts of the Satara, Sangli, Nasik and Kolhapur districts.

Red soils predominate in Chanda and Bhandara districts in the extreme east, and are formed of mixed parent material. These soils are sandy in texture and have a poor water-retaining capacity.

The mountainous terrain in the west is largely covered by the coarse soils of hill slopes and the clay loams of the valleys. Depending on the topography, they vary in depth from a few centimetres on hill slopes, to over a metre in the valley bottoms.

Shallow, medium and deep black soils derived from the weathering of basaltic material forming the Deccan trap, have a high clay content and are the predominant soils of the State. They vary in depth from the? deepest (more than 90 cm.) through the medium (22.5 to 90 cm.) to the shallow black soils (below 22.5 cm.). Below these soils is 'murrum' which consists of partially decomposed rock resting on the parent rock.

The development of salinity or of alkalinity in soils, results from the interaction of several factors such as the topography, the height of the water-table, the use of saline irrigation water, the ingress of sea water, and faulty farming practices.

Fairly large areas of the State have become affected by salinity or alkalinity through the operation of one or more of these several factors.

Over most of the State, topography plays a dominant role in determining the physical characteristics of the soils. The Deccan area, where the soils come from parent basalt, is intersected by rivers, streams and streamlets. The process of erosion by rain, wind and weather, and the transportation of soil particles by flowing water, leads to the distribution of soils. Coarse and shallow soils are found nearest the summits of ridges and table-lands, deep black, clayey loam soils are found in valley bottoms and, in between are the loamy soils of medium depth. Shallow and coarse soils exist, therefore, close to fine and deep soils, and there are many intermediate gradations of texture and depth. The general lay of the land, particularly in the proximity of streams and rivers materially affects the quality and distribution of soil.

Over most parts of Maharashtra, land on the banks of rivers is undulating with a sharp slope near the river. For this reason, alluvial soils, though deep and fine-grained, are well drained because of their proximity to the drainage lines.

Agro-climatic Regions

10.6 The State can be divided roughly into nine agro-climatic zones on the basis of climate, vegetation, relief, soils and cropping pattern.

In the high rainfall zone with lateritic soils which lies at altitudes varying from sea level to 500 m. are comprised the southern Konkan coast including Ratnagiri, the southern parts of Colaba, and the extreme western

parts of the Kolhapur and Satara districts. The rainfall which is distributed over 100-110 rainy days, ranges between 200 and 300 cm per annum. The annual evaporation is 190 to 200 cm. The dominant soil is laterite formed from basalt. Salinity has developed in small patches of soil near river mouths. Paddy is the predominant crop in the low lying areas and millets in the uplands. Fruit farming is practised on a wide scale there.

Included in the high rainfall zone with non-lateritic soils which has the same elevation, precipitation and evaporation, as the preceding zone are the northern Konkan area comprising the districts of Thana, north Kolaba and the extreme western parts of the Nasik, Ahmednagar and Poona districts. The predominant soils are red to reddish-brown loams of a non-lateritic origin. Soils near river mouths are alluvium or saline alluvium. The crops grown are mainly millets and pulses. It is a good area for orchards and garden crops.

High rainfall zone with soils formed from mixed parent material, which includes the districts of Chanda and Bhandara and the eastern part of the Nagpur district, is level with an average assured rainfall of 70 cm to 125 cm. The soils are derived from gneisses, granites, Dharwars and Vindhyans, and are either red sandy loams or deep black clays. Paddy is the predominant kharif crop, and wheat and linseed predominate in rabi.

Included in the ghat zone of the Sahyadri range and its western slopes, 500 to 1500 m. in elevation, are the western parts of Kolhapur, Sangli, Satara, Poona, Ahmednagar and Nasik. The average annual rainfall is 200 to 400 cm, and the evaporation 230 to 317 cm. On the hill slopes, the soils are shallow light-brown to dark-brown gravelly loams. The high level western parts of the zone contain red to reddish-brown lateritic soils. The predominant crop is millets.

The Eastern slopes of the Western Ghats which fall in the districts of Satara, Poona, Ahmednagar, Nasik and Dhulia, are comprised in the transition zone I with an elevation varying from 500 to 1000 m. The precipitation is from 125 to 250 cm and the evaporation 230 to 317 cm. The red and black soils found in this zone come from parent basalt rock. The heavy monsoon rainfall suits the growing of paddy, even at high elevations. Lower down, bajra, jowar and groundnut are the principal crops.

Transition zone II which is characterised by rolling plains interspersed with rocky outcrops, includes the mid-western portions of the districts of Dhulia, Nasik, Ahmednagar, Poona, Satara and Sangli, and the north-eastern portion of the Kolhapur district. The altitude varies from 300 m to 1000 m, and the rainfall between 70 and 125 cm. The whole zone is underlain by Deccan trap, and covered by brown to dark-brown soils of varying depths. The predominant crops in the kharif season are bajra, jowar and groundnut, though paddy is grown in patches.

Scarcity zone is a vast rolling plain at an average elevation of 600 m

and includes the eastern portions of the Dhulia, Nasik, Ahmednagar, Poona, Satara and Sangli districts and the western portions of Bhir, Sholapur, Osmanabad and Jalgaon districts. The rainfall ranges from 50 cm to 70 cm, but is badly distributed. The zone is underlain by Deccan trap and is covered by brown-black calcareous soils of varying depths and textures. Crops are grown both during the kharif and rabi seasons.

Assured rainfall zone at an average elevation of less than 600 m includes the major part of the districts of Jalgaon, Aurangabad and Osmanabad, and the eastern parts of the districts of Bhir, Akola, Amraoti, Nanded and Parbhani. The precipitation varies between 70 cm and 90 cm and gives assured rains for the kharif crops, which largely consists of jowar, cotton and groundnut. The soils, which are formed from the Deccan trap, are dark-brown to black calcareous clay loams of varying depth.

Moderate rainfall zone is a gentle rolling plain at the same altitude as the assured rainfall zone, and includes the districts of Wardha, Nagpur, Yeotmal, and a portion of the district of Amraoti. The rainfall which is well distributed during the period of the south-west monsoon ranges from 90 cm to 125 cm. The brown-black soils are derived from the Deccan trap and vary in depth and texture. Alluvial soils cover the valleys of the Tapi,

Table 10.1

Land Use Details in Maharashtra

Classification	Area (Thousand hectares)	Per cent of the Reporting area
1	2	3
Reporting area	30,768	—
Forests	5,419	17.6
Not available for cultivation	2,471	8.0
Other uncultivated land excluding fallow lands	2,290	7.5
(a) Permanent pastures & other grazing lands	1,380	4.5
(b) Land under misc. tree crops and groves	194	0.7
(c) Cultivable waste	716	2.3
Fallow lands	2,221	7.2
Net area sown	18,367	59.7
Area sown more than once	1,000	—
Gross cropped area	19,367	—
Net irrigated area	1,375	—
Gross irrigated area	1,557	—

the Wardha and the Penganga. Kharif crops are grown extensively on the heavier soils. Rabi crops are also grown.

Land Use Pattern

10.7 The geographical area of the State is 30.8 million hectares. Table 10.1 shows the pattern of land use in 1968-69.

Of the total reporting area, the net area sown is about 60 per cent compared to the All-India average of 45 per cent. Not more than 5.4 per cent of the gross cropped area is double-cropped.

Cropping Pattern and the Principal Crops

10.8 In 1968-69 the gross cropped area in Maharashtra was 19.4 million hectares. About 71 per cent of this was under food crops, 14 per cent under cotton, 9 per cent under oilseeds and 5 per cent under fodder crops.

The most important of the food crops according to the area sown are jowar, bajra, paddy and wheat. Among the non-food crops, the most important are cotton, groundnut and sugarcane. Sugarcane is important as a cash crop, but the area covered by it is not large.

Maharashtra is by far the most important jowar and cotton producing State and accounts for about ⅓ of the acreage in the country under each crop. It also accounts for 13 per cent of the total acreage in the country under groundnuts.

The cropping pattern varies from region to region. In Konkan and in the eastern districts of Chanda, and Bhandara, paddy is the predominant crop. In the Nagpur and Aurangabad divisions and in the districts of Dhulia and Jalgaon, it is cotton. Jowar, bajra, groundnut and wheat are raised everywhere in the State except in Konkan. Sugarcane is confined to irrigated areas. Jowar and cotton which are the most important crops of the State, claiming 30 per cent and 14 per cent respectively of the total cropped area, receive very little irrigation. The actual irrigated area under these crops is 5 per cent in the case of jowar and a mere 2 per cent in the case of cotton.

On the other hand, the irrigated areas under rice, wheat and gram are much larger, being 23 per cent, 28 per cent and 16 per cent respectively. Most of the irrigated rice is grown in the eastern districts of Chanda and Bhandara which get 1400 mm to 1525 mm of reasonably well-distributed rain. However, the rains frequently end by the middle of September, and irrigation from the multitude of small village tanks has to be given till the end of October.

The extent of the irrigated cropped area varies widely from district to district. While the major rice growing districts of Chanda, Bhandara and Nagpur have 50 per cent of land under rice irrigated, Kolaba and Ratnagiri have less than 4 per cent irrigation.

Table 10.2 gives the cropping pattern of the State in the year 1968-69, the latest year for which figures are available,

Table 10.2

Cropping Pattern in Maharashtra

Crop	Area (Thousand hectares)	Per cent of the total area
1	2	3
Rice	1,328	6·86
Jowar	5,885	30·39
Bajra	2,034	10.50
Wheat	839	4.33
Other cereals	461	2.38
Total cereals	10,547	54.46
Total pulses	2,633	13.59
Total foodgrains	13,180	68.05
Sugarcane	201	1.04
Condiments & spices	197	1.02
Fruits, vegetables and other food crops	194	1.00
Total food crops	13,772	71.11
Groundnut	928	4.79
Other oilseeds	830	4·29
Cotton	2,716	14.02
Other fibres	95	0.49
Fodder and other non-food crops	1,026	5.30
Total non-food crops	5,595	28.89
Total under all crops	19,367	100.00

One feature of irrigation in the State is that while the farmer uses irrigation water only for food crops during the kharif season, he prefers to irrigate sugarcane, orchard crops, fodder and vegetables in the rabi season.

The incidence of dug wells is the highest in canal irrigated areas, clearly indicating the beneficial effect of canal irrigation on the level of the water table.

Production of the Principal Crops

10.9 Table 10.3 indicates the production of cereals and cash crops from 1955-56 to 1968-69.

During the years 1955 to 1966 there was a general spurt in the production of foodgrains, with an unusually good year in 1960-61 and an unusually poor one in 1965-66. In absolute terms, the production of foodgrains in-

Table 10.3

Production of Principal Crops

(Thousand tonnes)

Year	Jowar	All cereals	All pulses	Total food-grains	Cotton (Lint)	Sugar-cane *(Gur)*	Ground-nut
1	2	3	4	5	6	7	8
1955-56	2,584	4,642	932	5,574	136	683	718
1960-61	4,224	6,755	989	7,744	284	1,156	800
1965-66	2,329	4,050	672	4,722	181	1,054	450
1966-67	3,208	5,308	742	6,050	194	1,114	470
1967-68	3,393	6,003	822	6,825	244	1,189	744
1968-69	3,548	6,284	874	7,157	244	1,428	648
1969-70*	3,214	6,075	839	6,914	218	1,625	615
1970-71**	1,591	4,814	776	5,590	87	1,679	617

*Partially revised estimates.
**Final estimates.

creased from a total of 5.57 million tonnes in 1955-56 to 7.16 million tonnes in 1968-69. Non-food crops also indicate a similar trend. The production of most crops declined in 1970-71 due to a poor monsoon in some areas of the State. Even the record production of 7.16 million tonnes in 1968-69 was only 73 per cent of the food requirements of the State.

Cropping pattern in Irrigated Areas

10.10 During the past 10-15 years the cropping pattern in the irrigated areas of the State has undergone a change. In Nanded and Satara districts, the percentage of the irrigated area under rice has decreased. In Dhulia and Jalgaon districts there has been a marked shift from wheat to cotton and sugarcane. The irrigated area under jowar in the districts of Aurangabad, Bhir and Osmanabad and that of sugarcane in the districts of Poona, Satara and Kolhapur has increased. There has been a considerable increase also in the irrigated area under cotton in the districts of Nasik, Jalgaon, Ahmednagar, Poona, Aurangabad, Bhir, Buldana, Yeotmal and Wardha.

Water Resources

10.11 The three major rivers which flow through Maharashtra, viz. the Krishna, the Godavari and the Tapi, are all inter-State rivers. The Krishna which rises in the Western Ghats, just north of Mahabaleshwar,

flows out of Maharashtra through Mysore and Andhra Pradesh and into the Bay of Bengal. The Godavari rises in the Nasik district of Maharashtra and flows across the Deccan plateau, through Andhra Pradesh and Madhya Pradesh before emptying itself into the Bay of Bengal. The Tapi, which rises in the Betul district of Madhya Pradesh flows through Maharashtra and Gujarat on its way to the Arabian Sea.

The total area drained by the Krishna is about 259 thousand sq.km. Of this area 27 per cent lies in Maharashtra and the balance in Mysore and Andhra Pradesh. The Godavari has a total drainage area of about 313 thousand sq.km of which about 152 thousand sq.km lie in Maharashtra, and the balance in the States of Madhya Pradesh, Andhra Pradesh, Mysore and Orissa. Of the 65,000 sq.km which form the drainage area of the Tapi, as much as 52,000 sq.km lie in Maharashtra and the balance in Madhya Pradesh and Gujarat.

In addition to these major rivers, there are a number of small west-flowing rivers like the Tansa, Vaitarna, Ulhas, Savitri and Vagothan which carry heavy discharges during the monsoon and flow across the Konkan coastal belt to the Arabian Sea.

Surface Water Potential

10.12 The estimated average flows in the major rivers flowing through the State, on the basis of a 75 per cent dependability are given in Table No. 10.4.

Table 10.4

Average Annual Flows of Rivers of Maharashtra at 75 per cent Dependability

(m.cu.m.)

River	Average annual flow
1	2
West-flowing streams in Konkan	42,480
Krishna basin (including the Bhima sub-basin)	27,920
Godavari basin (including Pranhita and Indravati sub-basins)	37,830
Tapi basin	7,250
Narmada basin	620
Total:	116,100

At 50 per cent dependability, the figure would be 147,730 m.cu.m.

Of the total flow, 42,480 m.cu.m. is accounted for by the west-flowing rivers, but because of the ruggedness of the terrain and the steep gradient, most of this water cannot be harnessed. What can be utilised is only 5,950 m.cu.m or 14 per cent of the total flow.

10.13 Based on the available run-off and rain-gauge data, the State Government has estimated the extent of the irrigable command of rivers in the State to be, as shown in Table 10.5.

Table 10.5

Irrigation Potential of Maharashtra—By Surface Sources

(Thousand hectares)

Name of the basin	Culturable area	Irrigable command	Per cent (Co. 3 to 2)
1	2	3	4
Krishna	1,615	508	31.4
Bhima	4,105	687	16.7
Godavari Proper	6,350	1,072	16.9
Pranhita	4,840	1,880	30.9
Indravati	215	57	2.7
Tapi	3,352	523	15.5
West-flowing rivers	1,745	270*	15.4
Narmada	50	4	0.08
Total:	22,272	5,001*	22.5

*Of this 110 thousand hectares comes from the Krishna by diversion of some of its water westwards.

Source : Preliminary Memorandum by Maharashtra State.

On the basis of 75 pẹr cent dependability, the total area which could be brought under irrigation in the State is about 5.0 million hectares, which includes 0.6 million hectares within the command of wells, which derive their water through seepage from canals and irrigated fields. These 0.6 million hectares would more appropriately be shown as irrigated from ground water.

It is estimated that at least an additional 0.6 million hectares could be irrigated if the wastage from canals could be controlled by lining them. On a 50 per cent dependability, the total area irrigable from surface flows would be 5.0 million hectares.

10.14 The total area irrigable from wells in the State is estimated at 1.5 million hectares, of which 0.6 million hectares are within the command of various irrigation projects; and 0.9 million hectares outside.

10.15 On the basis of a 75 per cent dependability of irrigation from surface flows, and the estimated ground water potential mentioned, the overall irrigation potential in the State is estimated to be 6.5 million hectares. This figure assumes a cent per cent intensity in canal irrigation, though, in practice, it is lower.

The culturable area in the State being about 22.3 million hectares, the irrigation potential is 29 per cent of the total. Additional areas could be brought under irrigation to increase the potential to 32 per cent if efforts are made to utilise the flows of 50 per cent dependability.

Present Stage of Irrigation Development

10.16 The rivers of the State carry enormous quantities of water during the monsoon months, but very little during the rest of the year. It was this characteristic of their flows, which inhibited the development of irrigation in the pre-British and early periods of British rule. However, the frequency of drought and famine revealed the vulnerability of agriculture over large tracts of the State, and made it imperative to provide protective irrigation. A beginning was made with the construction of tanks and small canals, and the improvement to small irrigation works. By about 1870, the Krishna Canal in Satara district, three small canals in Nasik district fed by the river Kadva, and the Mukti Tank in Dhulia district had been constructed. However, it was soon realised that without the support of storage reservoirs, the irrigation system in the State could not afford a reasonable degree of protection against drought, or support crops at critical periods of their growth. This led to the construction of a storage dam at Khadakwasla and the Mutha system of canals, the construction of a tank at Ekruk near Sholapur and of the Lekh Canal from the river Pravara.

The acceptance by the Government of its responsibility to provide protective irrigation to vulnerable tracts and the liberalisation of financing criteria which followed, led to an increase in the development of irrigation. Works like the Nira Canal, and the Mahaswad, Shetpal and Khetpal Tanks were taken up and completed during this period. Some of these were taken up as relief works during the 1877 famine.

On the basis of the First Irrigation Commission's recommendations a number of new works including the Godavari Canal, the Girna Left Bank Canal, the Chankapur Tank and its distribution channels were taken up. Simultaneously, work was carried out on remodelling, improving and extending the Pravara and Nira Canals.

No irrigation work of any significance was taken up during the pre-Independence period in the vulnerable Marathwada region. However, a large number of tanks were excavated during the first two decades of the century in the Vidharbha region, which then formed part of the erstwhile Central Provinces. The Ramtek Tank in Nagpur district, the Chandapur, Khairbhanda, Chor Khamara and Bodulkasa Tanks in the Bhandara district, and the Kairee, Ghorajhari and Naleshwar Tanks in the Chanda district were excavated during this period. Then followed a period of inactivity lasting nearly three decades up to the partition of the country, when no new works were taken up.

10.17 Irrigation development in Maharashtra gained momentum after Independence and in particular with the advent of the Plans. As many as 18 major and medium projects were taken up during the First Plan, 30 during the Second Plan, 6 in the Third Plan and 28 during the Annual Plans between 1966 and 1969. These were supplemented by some non-Plan works taken up by the State Government.

The major non-Plan projects taken up during the Plans were:

1st Plan	The Ghod Project.
2nd Plan	The Vir, Purna, Girna, Bagh, Itiadoh, Mula and Khadakwasla Stage I, which were spilled into the 3rd Plan period.
Annual Plans	The Bhima, Jayakwadi Stage I, Krishna, Warna, Upper Godavari and Kukadi Stage I.

The projects on the Ghod, the Vir, the Purna and the Girna were completed at an estimated cost of Rs. 398 million. Their irrigation potential is about 170 thousand hectares.

A total of 67 medium irrigation projects were taken up between 1950 and 1969, and of these 41 have been completed. Table 10.6 indicates the position of the post-Independence major and medium irrigation projects.

Continuing Projects

10.18 Inclusive of the continuing Schemes from the earlier Plans 37 schemes have been included in the Fourth Plan, of which 10 are major works. The present position of the more important among them is briefly described below:

Bagh Project:

The Bagh scheme is jointly sponsored by the States of Maharashtra and Madhya Pradesh, who will share the potential of 278 m.cu.m. of water in the ratio of 3:1. The water of the Bagh will be impounded by two earthen dams. The length of the canal in Maharashtra will be 64 km to irrigate an area of 33,700 hectares. It is planned to complete the dam with

Table 10.6

Major and Medium Plan Projects

Projects included under	Major Projects			Medium Projects		
	Completed	Continuing	Total	Completed	Continuing	Total
1	2	3	4	5	6	7
First Plan						
(a) Number	1	—	1	17	—	17
(b) Cost (Rs. million)	55.60	—	55.60	111.58	—	111.58
(c) Benefit (000 hectares)	24.60	—	24.60	62.00	—	62.00
Second Plan						
(a) Number	3	4	7	20	3	23
(b) Cost	342.30	456.20	798.50	219.75	93.50	313.25
(c) Benefit	145.40	167.70	313.10	81·28	29.44	110.72
Third Plan						
(a) Number	—	1	1	1	4	5
(b) Cost	—	51.28	51.28	9.90	55.39	65.29
(c) Benefit	—	11.72	11.72	1.21	23.56	24.77
Annual Plans (1966-67 to 1968-69)						
(a) Number	—	6	6	3	19	22
(b) Cost	—	1,719.74	1,719.74	14.65	237.09	251.74
(c) Benefit	—	564.80	564.80	4.27	86.62	90.89
Total All Plans						
(a) Number	4	11	15	41	26	67
(b) Cost	397.90	2,227·22	2,625.12	355.88	385.98	741.86
(c) Benefit	170.00	744.22	914.22	148.76	139.62	288.38

its canal system during the Fourth Plan at an estimated cost of Rs. 58.40 million.

Itiadoh Project:

The Itiadoh dam and its canals are to be completed during the Fourth Plan at a cost of Rs. 69.2 million. The earthen dam will be 28 m. high and the main canal 80 km long, with 40.23 km of branch canals, irrigating an area of 46,136 hectares.

Khadakwasla Stage I:

This project, which had to be remodelled after the failure of the Panshet dam in 1961, will consist of a new earthen dam on the Ambi river at Panshet to store 312 m.cu.m. of water to irrigate 22,298 hectares. It also involves the strengthening of the old Khadakwasla dam, and the addition of 127 km of canals. The total cost will be about Rs. 167 million. The project is expected to be completed by the end of the Fourth Plan.

Mula Project:

Begun in 1959, this project ran into foundation difficulties which greatly retarded its progress so that the construction of the dam lagged behind that of the canal. It was expected to be completed in 1971-72. The earth dam is 46.6 m. high to store 736 m.cu.m. of water. The 75 km of canals will command an area of 65,560 hectares.

Bhima Project:

This project which is likely to be completed only by the end of the Fifth Plan envisages two composite dams, one on the river Bhima and the other on its tributary, the Pawna. It will benefit 131 thousand hectares.

Work on the Pawna dam has begun and is expected to be completed by the end of the Fourth Plan. A part of the Ujjani dam on the Bhima with cross-drainage works, and about 48 km of canals commanding an area of 5,300 hectares will be completed by the beginning of the Fifth Plan.

Jayakwadi Stage I:

A storage dam across the Godavari to impound 290 m.cu.m. of water with a canal 185 km long to irrigate 1,14,665 hectares is the objectives of this project. During the Fourth Plan, it is proposed to complete the dam fitted with crest gates, the left bank canal and a part of the distribution system.

Krishna Project:

This is a triple dam project, impounding a gross volume of 812.42 m.cu.m. of water and served by 367 km of canals. The cost of the project is expected to be of the order of Rs. 276.6 million, and the area irrigated 106,290 hectares. By the end of the Fourth Plan, one of the three dams and 81 km of canals will have been completed, and work on the second dam started.

Warna Project:

This project is expected to be completed by the end of the Fifth Plan at a cost of Rs. 311 million. It will irrigate nearly 99 thousand hectares of land, through 341 km of canals. The dam will be 51.5 metres in height, and impound 2,469 m.cu.m. of water. During the Fourth Plan, a part of the main canal and about 2.5 m.cu.m. of earth work on the dam will be completed.

Upper Godavari Project:

Work on this quadruple dam project began in 1968, and the first stage of construction is expected to be completed by the end of the Fourth Plan. The canals will have a total length of 133 km and will irrigate about 44 thousand hectares.

Kukadi Stage I:

The project is a triple dam project with 124 km of canals, to irrigate 42,700 hectares, at a cost of Rs. 179 million.

Pus Project:

The Pus is a tributary of the Wainganga and it is planned to put an earth dam across it to provide irrigation to 11,715 hectares at a cost of Rs. 51.3 million.

In addition, new projects which are proposed for inclusion in the Fourth Plan, are the Dudhganga, Pench, Lendi, Surya, Mahaladevi, and Sahasrakund and Khadakwasla Stage II.

Irrigation from Wells

10.19 Wells are undoubtedly the most important source of irrigation in Maharashtra, since they irrigate more land than all other sources of irrigation put together. The wells number over 700,000 and command 797,000 hectares, or 58 per cent of the total area under irrigation. More than 130,000 wells are now fitted with pumps.

Source-wise Irrigation

10.20 The net areas irrigated from various sources in 1951-52 and in 1968-69 are shown in Table 10.7.

Table 10.7

Source-wise Irrigation

(Thousand hectares)

Source	1951-52	1968-69
1	2	3
Government Canals	208(24)	248(18)
Private Canals	23(3)	28(2)
Tanks	179(21)	224(16)
Wells	405(48)	797(58)
Other sources	36(4)	78(6)
Total:	851(100)	1375(100)

(Figures within brackets indicate per cent to total)

In 17 years 1952 to 1969 the net irrigated area in the State has increased by 524 thousand hectares, three-fourths of it being due to the extension of the area irrigated from wells. The increase in area irrigated from other sources, including Government canals was small.

Ayacut Development

10.21 In Maharashtra, there is very limited scope for an increase in cropped area. It is through intensive agriculture alone that any marked increase in food production can be achieved. The agro-climatic conditions of the State are favourable to maximising yields through irrigation. Thus, ayacut development acquires the highest importance for Maharashtra. We would draw the attention of the State Government to our recommendations in Chapter VII of Volume I relating to ayacut development.

We found that the farmers in the command of some projects where rainfall is good, did not feel inclined to use irrigation waters during the kharif season in the hope that rains may come. Similarly, in areas where the normal winter rainfall ranges between 150 mm and 250 mm, the farmers are reluctant to use irrigation water. However, when their expectations of rainfall fail, the loss of the crop is tremendous. It should not be overlooked that irrigation in such areas is protective. We would recommend to the State Government to examine whether the existing system of optional irrigation should not be replaced by a system like the Warabandi of northern States. All the lands underlying an outlet should be made liable to pay water rates, whether the farmers make use of the water or do not make use of it. As the irrigation waters will not always be required, the rates may be fixed at a lower level.

10.22 Although the different Irrigation Acts prevailing in the State make it obligatory on the irrigators to construct and maintain field channels, for reasons which are common to the whole of India, field channels have not been constructed.

The Maharashtra Government has placed the responsibility for constructing field channels from outlets with a discharge of 0.04 cumec on the Soil Conservation Section of the Cooperative Department. The work is executed under the Land Improvement Schemes Act of 1942 and the cost of the field channels is recovered in fifteen annual instalments from the beneficiaries. The responsibility for maintaining the field channels rests on the cultivators and if they fail to discharge it effectively, the Agriculture Department has the power to take over the maintenance and recover the cost of maintenance plus an additional sum of 25 per cent from the defaulting beneficiaries.

10.23 The work of land levelling and land shaping in the ayacut of 17 major and medium projects is done through the Department of Agriculture. This Department also constructs field channels with masonry structures such as diversion boxes, drops and crossings, graded bunds in falling contours, dry-rubble outlets, draw-off channels and field drains. The programme aims at covering 24,300 to 28,300 hectares every year for the next ten years. We understand that due to the scarcity of labour and machinery, the work is lagging behind.

Concessional Water Rates

10.24 In order to encourage the farmer to take to irrigation, the Canal Department gives concessions in water rates during the first three years of the commencement of an irrigation project. These concessions are mentioned in Appendix 10.4

Arrangements for Credit and Inputs

10.25 The Cooperative Societies have been strengthened to enable them to advance loans to farmers in the ayacut. Arrangements have also been made for the timely and adequate supply of inputs like seeds, fertilisers and pesticides. A beginning was made with Bhandara district and the scheme has been extended to areas selected under the Intensive Agricultural Areas Programme and later also to areas covered by the High-Yielding Varieties Programme.

Demonstration Farms

10.26 Eleven trial-cum-demonstration farms have been set up in the command areas of various projects which represent different agro-climatic zones in the State. At these farms research is being conducted on problems relating to irrigated agriculture. They have also programmes to demonstrate the new technology to the farmers.

For demonstrating advances in technology, 22 irrigation units have been established in various ayacuts to organise demonstrations on the farmer's fields. As many as 1158 demonstrations were laid in the year 1968-69. On these fields demonstrations were laid on the economic methods of using water and fertilisers, the scientific rotation of crops and double and multiple cropping.

Project Coordination Committees have been set up on all major and medium projects to coordinate the activities of the various Government departments and agencies like the Cooperatives and Zila Parishads. These Committees are headed by Additional Development Commi-

ssioners. They are reported to have improved the quality of ayacut development.

Organisational Set-up for Ayacut Development

10.27 In the State Department of Agriculture, an irrigation cell, headed by an Additional Director of Agriculture, has been created to guide and control ayacut development. He is assisted by Joint Directors for planning, extension, soil conservation and horticulture, and by Assistant Directors for the utilization of irrigation. This unit deals with ayacut development and prepares reports on the utilisation of irrigation, and on general agricultural development.

At each of the Divisional Headquarters, i.e. at Nasik, Poona, Aurangabad and Nagpur, the Superintending Agricultural Officer in-charge of the ayacut development programme has Deputy Directors, Agricultural Supervisors and Agricultural Assistants to assist him.

The extension work relating to irrigated agriculture is carried out by 24 irrigation units. Besides, for doing rapid topographical survey of command areas, two survey units have been established, each of which surveys about 113 thousand hectares a year.

The work of land development is being done through three soil conservation divisions and 16 sub-divisions under the Director of Agriculture.

Land Improvement

10.28 Maharashtra is one of the few States to take up contour bunding, trenching, gully plugging and afforestation on a massive scale. In Bijapur district (now a part of Mysore) and in Sholapur district, measures to prevent erosion and conserve soil moisture were taken up as far back as 1943. The extent of these remedial programmes during the Third Plan and the three annual plans is given in Table 10.7.

Soil Conservation

10.29 A special department for soil conservation was set up by the State Government in 1967-68, and the Government proposes to survey 820,000 hectares of land to put through a comprehensive soil conservation programme. The Agricultural Refinance Corporation will provide Rs. 250 million for this programme. The programme is a State enterprise and not included in the centrally sponsored soil conservation programme for selected catchment areas.

Table 10.7

Land Improvement Works

(Thousand hectares)

Work	During Third Plan	1966-67	1967-68	1968-69
1	2	3	4	5
Bunding	1,917	645	548	546
Terracing	19	14	14	10
Land Reclamation on khar lands	12	2	2	3
Afforestation on water shed basis	18	6	4	4
Land development-cum-horti-culture	5	6	6	8
Soil conservation in catchment areas of river valleys	1	2	1	1

Consolidation of Holdings

10.30 Holdings in Maharashtra were generally too fragmented and made progressive farming difficult. A total of 19.0 million hectares required consolidation. By the end of 1968-69 an area of 3.97 million hectares or roughly $\frac{1}{5}$th of the total had been covered by consolidation operations.

The Fourth Plan programme for the consolidation of holdings covers an additional 3.32 million hectares.

Intensive Cultivation

10.31 The State Government has taken up a programme of intensive cultivation in compact blocks, of food crops, including pulses. A special extension unit was set up for each block. By the end of 1968-69, an area of 3.1 million hectares had been covered by 338 such intensive cultivation blocks, including 1.19 million hectares taken up under the 'high-yielding varieties' programme. The programme for intensive cultivation includes the use of improved seeds, fertilisers and crop protection measures, and the timely supply of credit. The response has been encouraging.

In the Fourth Plan, a target of 150 intensive cultivation blocks has been included. By the end of the Fourth Plan, 488 blocks will cover an area of 4.4 million hectares.

Rural Electrification

10.32 Wells being the vital feature of the irrigation system in Maharashtra, the rural electrification programme to energise agricultural pumps was rightly given a high priority.

During the Fourth Plan, it is proposed to energise 70,000 additional agricultural pumps, which will bring the total number of pumps energised to 193,000.

In addition to this, a sum of Rs. 10 million has been provided by the State Government for rural electrification and the Agricultural Refinance Corporation has agreed to give a loan of Rs. 190 million for the same work.

It is expected that about 220,000 hectares of land will be benefited by irrigation on the completion of the electrification programme.

Drought Areas

10.33 In 1958, the erstwhile Bombay State had set up a 'Fact Finding Committee' to identify the scarcity areas in the State, and to suggest measures to ameliorate the condition of the population of these areas.

The Committee divided the scarcity areas into three categories, based on factors such as rainfall and its variability, annawari and land revenue suspensions, and the number of occasions when an area had been declared to be affected by scarcity during the last 30 years. These categories were:

A. Where there had been a total or almost total failure of crops once in three years.

B. Where there had been a total or almost total failure of crops once in six years.

C. Where there had been a total or almost total failure of crops once in ten years.

The State Government accepted these criteria for the identification of scarcity areas, and, on the basis of information available subsequently, it included some additional areas to those recommended by the Committee. The details of the area and population involved are given in Table 10.8. Based on these criteria, 53 taluks in 9 districts were found to be scarcity affected which accounted for 17 per cent of the geographical area of the State and 13 per cent of its population.

Subsequently, the State Government had second thoughts as to the reliability of the criteria based on the frequency of the suspension of land revenue collections, that is, on the annavari. It felt that the annavari record was not reliable. In the Memorandum to the Commission, the State Government suggested the following criteria for the identification of scarcity areas:

(a) Where the normal rainfall is less than 508 mm.

(b) Where the dependable rainfall in the crucial months of September

Table 10.8

Scarcity Affected Areas and Population

Category	Affected by Chronic Scarcity		Population in thousands (1961 Census)
	No. of villages	Area (Sq. km)	
1	2	3	4
A	499	9,046	740
B	961	17,744	1,430
C	2346	26,136	2,760
Total:	3,806	52,926	4,930

Source: Preliminary Memorandum by the Maharashtra Government.

and October falls below the minimum of the 152 mm necessary for the germination of rabi crops.

Based on these criteria the scarcity areas were increased to cover 147,262 sq. km, that is, 48 per cent of the total geographical area. It included 112 taluks, of which 62 wholly and 50 partially, fell in the category of scarcity areas.

In Chapter VIII of Volume I we have dealt in some detail the criteria for identifying scarcity areas. We have recommended there that the selection of scarcity areas should be based on the degree of deficiency in rainfall and the extent of the adverse water balance. Other factors to be considered are the extent of irrigation and employment opportunities in the non-agricultural sector. The taluks, identified by the Commission as being drought affected, are mentioned in Appendix 10.1.

The Fact Finding Committee had made several suggestions to accelerate the development of scarcity areas and to protect them against drought and scarcity. Some of those suggestions have been taken up for implementation and others are awaiting investigation and sanction.

The State Government has also proposed a number of new works for the benefit of scarcity areas if the feasibility of such works is established. A list of irrigation works under construction and proposed by the State Government is given in Appendix 10.2.

The State Government has made good progress in surveying the ground water potential in the scarcity areas of Dhulia and Shrigonda. We would recommend that the survey should be extended to all districts within the

main drought zone so that the exploration of ground water through tube-wells, bore-wells, dug-wells etc. may be taken up on a big scale.

Future Development of Irrigation

10.34 After a somewhat halting start, the State Government has accelerated the pace of its programmes for irrigation. In the Third Plan the expenditure was ten times what had been spent on irrigation in the First Plan. During the Annual Plans (1966-69), programmes were so designed that investment yielded benefits quickly. In the case of projects which were in an advanced stage of construction at the end of the Third Plan, steps were taken to ensure that they yielded benefits by the end of the year 1968-69.

The policy of quickening the pace of construction to reap early benefits from investments continues to guide the Fourth Plan programmes. The organisational set up concerned with irrigation programmes has been strengthened.

A Water Resources Division has been created to make basin-wise assessment of the water resources of the State, and to prepare a Master Plan for the development and exploitation of these resources. The Central Designs Organisation will prepare designs for the project included in the Master Plan, and a body of mechanical engineers will deal with vital matters such as the operation, maintenance and repairs of heavy earth moving machinery and the manufacture of gates and spare parts.

The State Government has also drawn up perspective plans for the long-term development of the water resources in the basins of the Krishna and the Godavari. We are given to understand that similar plans covering the Tapi basin and the basins of the coastal rivers are being prepared. Special attention is being paid to the irrigation needs of the scarcity areas, and construction programmes have been designed to provide for irrigation in stages before the completion of projects.

The Master Plan for the development of the Krishna and Godavari basins visualises the utilisation of 84 per cent of the 75 per cent dependability flows in the Krishna and 78 per cent of similar flows in the Godavari. It is anticipated that when all the projects in these basins have been completed, 1.27 million hectares in the Krishna basin and 3.01 million hectares in the Godavari basin will be irrigated. It will account for 85 per cent of the total surface water potential of the State.

Lining of Canals

10.35 Because of the urgent necessity to make the best use of scarce water resources, the State Government has done much to improve the

efficiency of the canals by reducing seepage. Fortunately, the clay content of soils in Deccan, is high and seepage from canals through these soils is negligible. The seepage occurs when the canals pass through 'murram' and soft rock.

Surveys carried out by the State Government, revealed that as much as 14 per cent of water was lost through seepage from the Godavari Right Bank Canal during the hot weather, and about 10 per cent from the Nira Left Bank Canal and the Pravara Left Bank Canal each during both the kharif and the rabi seasons. On other canals, losses ranged from 4 per cent to 8 per cent.

Where the seepage losses are high, steps have been taken to insulate such reaches and make them leak-proof. Lining has been carried out on 45 km of the Lower Georia Canal taking off from the Dahigarh Weir; on 43 km of the Purna Canal; and on 19 km of the Khadakwasla Right Bank Canal. It is also proposed to line the whole 184 km length of the main Jayakwadi Canal.

According to the estimates of the State Government, if seepage losses can be cut down, and economies effected in the use of canal water, another 600 thousand hectares of land could be irrigated within the command of existing irrigation projects.

Repair & Renovation of Tanks

10.36 Tanks are an important source of irrigation in the State and account for more than 16 per cent of the net area irrigated. They include old malguzari tanks, particularly in districts of Nagpur, Chanda and Bhandara in Vidharbha. The management, repair and maintenance of tanks which irrigate 100 hectares or more is the responsibility of the State. Smaller tanks irrigating less than 100 hectares and percolation tanks from which no irrigation is done, are managed, maintained and repaired by Zila Parishads.

The silting up of tanks, particularly the old malguzari tanks is a perennial problem. The Committee on Plan Projects of the Planning Commission, observed that irrigation from the old malguzari tanks in the Vidharbha districts had declined from 157 thousand hectares in 1954 to 97 thousand hectares in 1960. Some tanks had fallen into disrepair and become defunct.

The State sponsored programme for the repair and renovation during the Fourth Plan period envisages—

(i) Resectioning of bunds to bring them to the required standard,
(ii) providing waste weirs to discharge flood water,
(iii) increasing the storage capacity of tanks to extend the area under their command, and
(iv) repairing irrigation sluices, providing additional sluices to maintain

the existing irrigation, and repairing the existing canals and distribution systems.

The yardstick for assessing the economic feasibility of repair and renovation of tanks has been fixed as Rs. 1,040 per hectare of ayacut. Where it is not feasible to implement a scheme within this limit only repairs to stabilise the existing irrigation are undertaken.

No programme for the repair and renovation of tanks under the management of the Zila Parishads has yet been prepared. These tanks are fast deteriorating for want of funds. We are of opinion that a counterpart programme for the repair of the tanks should be taken up.

Renovation of Wells

10.37 In 1965-66 there were 620,000 wells in the State irrigating in all 711,000 hectares of land or 60 per cent of the total irrigated area of the State. This is an indication of the dominant role of well irrigation in Maharashtra. In the three succeeding years, 67,000 more wells were dug. An additional 150,000 wells programme of digging is included in the Fourth Plan.

The Maharashtra State Irrigation Commission estimated that in the year 1958, about 18 per cent of the wells in the State went out of commission in the dry season. Assuming this percentage holds good today, the number of wells which does not work in dry season would be in the neighbourhood of 125,000.

The State Government has included a programme to renovate 50,000 wells during the Fourth Plan. We recommend that this programme be expanded, because of the critical role of the wells in the State. We have no doubt that expenditure on renovating old wells would be considerably less than on digging new wells.

In Sholapur and Wardha districts 780 and 4,000 wells respectively which have gone out of use, are proposed to be taken up for renovation. The State Government is advancing funds for the work through the Land Development Banks. We feel that similar schemes would be of immense benefit to other districts.

Floods, Waterlogging and Drainage

10.38 By and large, the State is free from floods and waterlogging. However, salinity has assumed serious dimensions in some of the old canal irrigated areas. In areas served by the Old Krishna Canal as much as 50 per cent of the irrigable command has become affected by salinity; and a large area has become waterlogged. The problem also exists, though not to the same extent, in the commands of the Nira, Pravara, Girna and Godavari Canals. Table 10.9 illustrates the present position:

Table 10.9

Waterlogged and Salinity Affected Areas

(Hectares)

Name of the river/canal	Total area irrigated (1968-69)	Area waterlogged	Area affected by salinity	Total
1	2	3	4	5
Nira Canals	67,707	647	11,804	12,451
Pravara	28,738	88	3,331	3,819
Godavari	30,141	160	6,226	6,386
Girna	5,766	76	805	881
Ghod	20,442	358	2,041	2,399
Krishna	3,816	238	1,617	1,855
Total:	151,700	1,567	25,824	27,391

The State Government is making extensive improvements to the drainage system in the affected areas. Of the 80 drainage schemes already completed, as many as 74 are in the command of the Nira, Pravara and Godavari Canals. Another 27 schemes are in progress, and 21 more have been proposed. Attempts are also being made to persuade cultivators within the command to construct field drains to prevent salt efflorescence.

We are given to understand that in the Irrigation Act which the State Government proposes to introduce to enforce uniformity in the incidence of irrigation levies in the State, there is a provision for the levy of a 'Flood Cess' in addition to the water-rates payable in respect of land or immovable property protected by flood embankments, or by drains. We feel that such a levy is desirable.

Financial Aspects, Water Rates and Betterment Levy

10.39 In Chapter X of the first volume we have dealt with the economics and financing of irrigation projects. We have traced the history of the criteria for the sanctioning of projects and have shown how the benefit-cost ratio came to be accepted as a suitable criterion. According to this criterion an irrigation work is feasible if the benefit-cost ratio is unity or above in the drought-affected areas.

We find that in Maharashtra all major irrigation works, and works costing from Rs. 30 to 50 million each are considered feasible if the benefit-cost ratio is 1.5 or above. For medium irrigation works costing less than

Rs. 30 million, and for minor works, the feasibility is accepted if the benefit-cost ratio is unity or above.

In the case of minor works an additional criterion for determining feasibility, is that in such works the cost per 0.028 m.cu.m. (1 Mcft.) of water stored should not exceed Rs. 25,000.

In drought areas, however, where the rainfall is low, cost of storage construction high, terrain difficult and labour scarce, the State Government has raised the ceiling on the cost to Rs. 30,000/- per 0.028 m.cu.m (1 Mcft) of water stored.

In the case of percolation tanks, the cost ceiling is Rs. 22,500 per 0.028 m.cu.m. (1 Mcft.) except in scarcity areas where it is Rs. 27,500.

Crop Planning in Irrigated Areas

10.40 In Maharashtra the soil survey of the command area under a storage reservoir is made. On the basis of the survey, the drainage condition of the land and the availability of water during each irrigation season, the project authority decides upon the percentages of heavy and light irrigation permissible in the area. A decision is also taken on the maximum area under perennials, within the command of each outlet (the 'X' limit as it is called). Finally, the individual farmers make applications for irrigation and sanctions are issued to each applicant for the irrigation of sugarcane and other perennials subject to (a) the suitability of the land to take heavy irrigation, (b) the 'X' limit of the area and (c) the ceiling for the release of water fixed for the project. Only 1/3rd to 1/4th of the area in a block, can be put under sugarcane each year. Since sugarcane is a 14 to 18 months crop, an overlap of 3 to 6 months is allowed to enable the farmer to keep the minimum area of 1/3 to 1/4 of the block under this crop each year.

The rest of the area grows seasonal dry crops during the monsoon, and in the winter season. Subject to the availability of water, blocks of other irrigated crops are given water on individual applications. In years of good monsoon rains, when there is ample water in the storage reservoirs, sanctions are also issued for the supply of water to other seasonal crops. Water for some varieties of cotton and groundnut is given during the months of May and June.

The responsibility for enforcing this system and the principles of distribution described above, lies with the State Department of Irrigation.

The benefits of the block system are available only to the land within the command of canals. Lands which are situated on the banks of the storage reservoir, between the reservoir and pick-up weir and along the upstream or uncommanded portions of canals are not benefited. The Government has allowed lift irrigation for such lands on the following terms:

(a) for areas upstream of the main storage, one per cent of the area under non-perennials in the project command;
(b) for areas between the main storage and the pick-up weirs 5 per cent;
(c) for areas upstream of canals 5 per cent.

Where the supply of water is made to big estates like the State Farming Corporation, it is given on a volumetric basis. For sugarcane 315 cm of water per year is made available at the head of the distributary.

10.41 The irrigation rates in Maharashtra are governed by three different Irrigation Acts applicable to three different regions namely Western Maharashtra, Marathwada and Vidarbha. The Bombay Irrigation Act of 1879 as amended in 1950 applies to Western Maharashtra; the Hyderabad Irrigation Act of 1952 to Marathwada and the Central Provinces Irrigation Act of 1931 to Vidarbha. The water rates charged in these regions are given in Appendices 10.3, 10.4 and 10.5. It will be observed that water rates in Marathwada and Vidarbha are substantially lower than those in Western Maharashtra. We understand that the State Government has taken a decision to bring water rates in different regions to the same level within four to eleven years. Appendix 10.6 gives the rates applicable to lift irrigation from various sources.

10.42 Irrigation cess was primarily meant to cover the cost of management, repairs and maintenance. It was imposed on the recommendation of a Cabinet Sub-Committee appointed in 1947. The recovery of the cess commenced from 1953 when rules were framed under the provisions of the Bombay Irrigation Act as amended in 1950.

The cess had been levied in Western Maharashtra since 1954. Appendix 10.7 gives the rate at present in force. No cess was or is being levied in Marathwada and Vidarbha regions.

The Maharashtra Irrigation Commission recommended that the cost of management and interest charges on the capital investment in irrigation projects should be recovered only through water rates and that no irrigation cess should be charged separately. The recommendation was accepted by the State Government though steps to implement the recommendation have not so far been undertaken.

The Bombay Irrigation Act as amended in 1950 makes a provision for the imposition of betterment levy on lands benefited by irrigation works which completed after 1950. In the Vidarbha region through the Madhya Pradesh Government Taxation Law Amendment Act, 1954 a betterment levy was imposed on works undertaken on or after the 1st April, 1951. In the Marathwada region the Hyderabad Irrigation Act of 1952 empowered the Government to collect a betterment levy on works completed after the 1st January, 1943. No rules have been framed under the laws applicable

to Vidarbha and Marathwada. In 1953 rules were framed under the Bombay Irrigation Act for the recovery of betterment levy in Western Maharashtra. Even there no betterment levy has been collected so far.

The most pressing issue requiring the attention of the State Government is to bring the water rates in the Vidarbha and Marathwada regions to the level of those obtaining in Western Maharashtra. The rates in Western Maharashtra also would need to be enhanced and modified keeping in view the principles enunciated by us in Chapter XI of the First Volume. The question of recovering betterment levy also calls for urgent attention.

During 1967-68, the latest year for which statistics are available the State Government incurred a loss of Rs. 57.60 million on the management and maintenance of irrigation works. The future programme of irrigation development prepared by the State Government and indicated to us in Chapter X—'A Perspective of Irrigation Development' in Volume I of the Report would roughly cost Rs. 15,000 million in the next three decades. The State Government shall have to bear the losses and the future expenditure in mind in revising the water rates.

Tour of Western Maharashtra

10.45 The Commission's tour of the State of Maharashtra was spread over two visits. The first visit extended from the 15th May to the 20th May, 1970 and the second took place after an interval of almost one year from the 29th April to the 3rd May, 1971. Our first visit began with a meeting with the Chief Minister, the Minister of Irrigation, some other Ministers and senior officers of the State Government at Bombay on the first day of the tour. All through, the discussions were marked by a deep understanding and appreciation of the necessity of irrigation in the State and an earnest desire to fulfil the programme efficiently and quickly.

On the tour we were accompanied by the Minister of State for Irrigation, the Chief Engineer, the Joint Secretary of the Irrigation Department and other officers. The State Government did us the courtesy of organising meetings of publicmen including M.Ps and M.L.As, irrigators, local officials and others, which were well attended. Those present at the meetings posed their problems to us and we on our part could get their reactions on problems pending before the Commission. We were impressed by the earnestness and awareness of irrigation problems among the participants in these meetings.

We were able to see many large and small irrigation works including the Koyna Dam and Power House, the Vir Dam, the Nira Right Bank Canal System, the Mula Dam site where work was in progress and the bandharas on the Panch-Ganga river. We also visited a cooperative lift-

irrigation scheme and private farms belonging to progressive farmers, as well as the Demonstration Farm at Khopoli, the Sugarcane Research Station at Padigaon and the Sakharwadi Farm of the Maharashtra State Farming Corporation.

We give below our impressions of the tours in various districts.

Ahmednagar District

10.46 The cultivators who met us at the Rahuri Cooperative Sugar Factory in Rahuri taluk complained of the rigidity of the block system and suggested that they should be allotted a quota of irrigation water and should thereafter have the liberty to grow crops of their choice. They said that the water requirement of various crops and the intervals for giving irrigation should be determined by the Agriculture Department and it should form the basis for the distribution of water by the Irrigation Department.

It was conveyed to us that supplies were released at intervals of 14 days which in itself was inadequate, but that even this frequency was not maintained during the hot weather, when it went up to 26 days.

For crops like cotton, bananas etc. which were planted from March to May, they wanted some release of water to be made before the onset of the monsoon. Once the rains come and canals run on high flows, water should be released to applicants without any restrictions.

When discussing the block system, they said that at present no overlap was allowed in the case of sugarcane, before July. They argued that as early planting of sugarcane greatly enhances the yield, permission for overlap before July should be given.

Some cultivators wanted relaxations in the present practice of disallowing wells in the area commanded by canals. They argued that the rule should be relaxed, and that wells should be allowed to be sunk in order to tap water which had seeped from the canals and irrigated fields and raised the underground water table. This seemed to us to be a sensible request and we would recommend that, subject to necessary restrictions about minimum distance from the canal and the spacing of wells, the State Government should examine the feasibility of permitting the digging of wells in the ayacut. This practice is prevalent in command areas of other canals, particularly where the intensity of irrigation is heavy. The withdrawal of water through wells from the underground accumulations would have the effect of preventing waterlogging and of improving drainage.

Some cultivators were of the view that higher priority should be given to measures for conserving water, such as soil conservation and construction of terraces, bunds and percolation tanks.

They also stressed the importance of taking up projects such as the Upper Ghod Project, and projects on the Sina and Adalla rivers to increase

irrigation in Ahmednagar district. Meanwhile, they wanted the Government to promote lift irrigation from rivers, even if permission was restricted to cooperatives.

Kolhapur District

10.47 At Kolhapur, the main points made by cultivators related to the cost of irrigation and the development of the ayacut.

Water rates in this district depend on the source of irrigation and the amount of water supplied. Sugarcane which was irrigated by lifting water from notified rivers, attracted a water rate of Rs. 150 per acre per annum. In the case of seasonals, the rates varied from Rs. 74/- to Rs. 99/- per hectare per annum. On big farms managed by sugar factories, rates charged were on a volumetric basis.

The cultivators who met us at a meeting in Kolhapur made the point that since the cost of irrigation works in the district was bound to be high, the usual yardstick of the benefit-cost ratio should be brought down from 1.5 to unity. They also suggested that, in that portion of the district which suffered from an acute shortage of water, the criterion for sanctioning irrigation schemes should be a 50 per cent dependability instead of 75 per cent.

Another point made was that the cost of agricultural operations in the district was high and for this reason the period of repayment of loans taken for digging wells, should be extended and the interest rates reduced. They also wanted loans to be advanced for such works as land-shaping and land-levelling.

We were particularly glad to note the keen interest shown by cultivators in irrigation. We found them wide awake to the importance of irrigation and to its role in improving agriculture. They stressed, inter-alia, the need for a comprehensive programme for the compulsory bunding of nallas, construction of percolation tanks, supply of electricity to energise pumps on wells, reduction of the timelag between the completion of storage works and the distribution systems in projects. They also stressed the need for measures such as land-levelling and land-shaping, construction of field channels and extension of distributaries.

Ratnagiri District

10.48 There are no major or medium projects in the district and the only perennial source of irrigation, at present, is the tail-waters of the Pophali Power Station of the Koyna Project. The Ratnagiri Zilla Parishad had completed 20 lift irrigation schemes to utilise these tail-race waters to irrigate sugarcane and the second rice crop. However, the irrigated area

is quite small. We were given to understand that the State Government is contemplating to construct a flow irrigation scheme from the Koyna system, after the proposed third stage of the Koyna Hydro-electric Scheme is completed. It is estimated that about 8,340 hectares will be irrigated under this scheme. At present, the total irrigated area in the district is barely 5,910 hectares.

The opinion held by people of the area generally was that if the plans for the westward diversion of the Kadvi, Kasari, Kumbhi, Vedganga and Hiranayakeshi, for generation of power could be implemented, and the tail-waters used for irrigation, it would transform the economy of the district. We were given to understand that in Ratnagiri district alone these schemes have an irrigation potential of 140.8 thousand hectares.

Among other suggestions, which appear to be quite sensible, were the promotion of lift irrigation out of funds provided for minor irrigation; introduction of short duration varieties of paddy to replace long duration ones; and use of sprinkler irrigation on undulating land. We were given to understand that experiments in the use of sprinkler irrigation were being conducted at two places on pineapple farms, and that the results had been encouraging.

Poona District

10.49 Our last meeting with cultivators was held in the Baramati taluk of Poona district. The points raised by them were generally on the same lines as at other places, namely, that in scarcity area there should be no rigid financial criteria for minor irrigation, and that funds should be provided liberally; that programmes for percolation tanks should be taken up; that lift irrigation should be encouraged; that water for irrigation should be released at timely intervals; that the cropping patterns should be modified and that sprinkler irrigation adopted. The additional points made out were (i) that additional storage in the Nira System be provided by completing storage dams at Gangavani and Natamba; and (ii) that cultivators were being charged 18 paise per unit of electricity, but the industries were charged only 6 paise per unit. This discrimination was unreasonable.

General

10.50 It became clear to us that the farmers took a lively interest in irrigation and there was eagerness among them to change over from dry farming to irrigated farming. We are of the opinion that in considering future programmes for the extension of irrigation area which have made good progress in the utilisation of the irrigation potential and particularly those

which have fully used up the irrigation potential should be given preference in allocating new projects. This should not however disturb the overriding priority being given to irrigation in scarcity area.

With regard to the financing of irrigation works, it is possible that the cultivator may advance funds for the development of irrigation, which could be adjusted against the water rates or the land revenue payable by them. If this proposal is found feasible, local schemes would get additional funds which may be taken note of in according preference.

We were given to understand that the State Government is thinking of utilising surface water resources of a 50 per cent dependability as against the generally accepted level of 75 per cent dependability. In this connection our observations on page 125 of the First Volume may be seen.

We would recommend that encouragement be given to the practice of filling up tanks at the tail-ends of canals and a survey may be made to establish feasibility of digging more tanks for being filled up during the monsoon. An additional benefit from this would be that by running canals during the rains the sub-soil water would be replenished.

Other possibilities which should be carefully explored are: (i) the use of sprinkler and trickler methods of irrigation, particularly in Kolhapur where costly lift irrigation is practised; (ii) the possibility of lifting water from the west-flowing river and diverting it eastwards; and (iii) the intensive exploitation of ground water.

Tour of Vidarbha and Marathwada

10.51 We toured the Vidarbha and Marathwada regions of Maharashtra in 1971 beginning from Nagpur, where we were able to hold discussions with some MPs, MLAs, MLCs, Presidents of Zila Parishads and some farmers. Thereafter, accompanied by the Secretary to the Government in the Public Works Department, the Chief Engineer and other officers, we visited a number of irrigation projects in the Vidarbha and Marathwada regions. We were able to visit the site of the Pench Dam, the Ramtek Tank and Canal and the Navagaon and Seoni Bandhs as well as the site of the Itiadoh Dam. In the Marathwada area, we had the benefit of personal discussions with Shri S. B. Chavan, Minister of Irrigation & Power, and also met some M.Ps, MLAs, Presidents of Zila Parishads and progressive cultivators of the area. We also visited the site of the Jayakwadi Dam. We record our observations of the two below:

Vidarbha

10.52 During the discussions at Nagpur, our attention was drawn to some features of water management in Vidarbha. The supplies of irrigation

water to farmers there are made either on the basis of long-term agreements extending up to 10 years entered into between farmers and the Irrigation Department, or on the basis of demand-forms tendered each season by cultivators. Though the rules under the C.P. Irrigation Act provide for the supply of water for both paddy and wheat, we were told that, in actual practice, the water was supplied for only paddy. In cases where crops other than paddy are grown, or where paddy is grown but the cultivator's land is not covered by a long-term agreement with the Department, irrigation water is supplied on the basis of demand-forms sanctioned for each crop season. The water rate for paddy under the agreement is Rs. 9/- per acre, and under the demand form Rs. 18/-. The rate for wheat is Rs. 8/- per acre.

Another anomalous feature of the system of irrigation for the purpose of agreements and demand-forms, is that only those land are recognised as 'wet' which were recorded as such in the settlement records of 1918. Areas not thus recorded, even though they may be under paddy now, are categorised as 'dry' because there has been no revision of the settlement after 1918. Further, the agreements for wet areas are dealt with by the Executive Engineers and those for dry areas, even though they may be growing paddy, are dealt with by the Canal Deputy Collector. Another question was, that once a cultivator had signed a demand-form, he was made to pay the water rate even if he did not avail of irrigation. The department's reply to this was, that once the cultivator signs the demand-form, he accepts the liability to take water, and if he fails to discharge his liability, he loses the right to get relief by the waiver of water rates.

The practice of supplying irrigation water on the basis of long-term agreements between farmers and the Department was introduced early in the century when farmers were reluctant to use irrigation water for growing crops on black-cotton soil. To induce farmers to take water, the Department offered them long-term agreements at low rates. The position has now greatly changed. Prejudice against irrigating black-cotton soil has disappeared, and the farmers do not need to be convinced of the benefits of irrigation. In fact they are very anxious to use irrigation water. In the circumstances, we feel that, the system of agreements has now lost its validity, and a new system more in keeping with the changed times and the changed needs should be introduced. The existing agreements between the farmers and the Department would have to be cancelled by law. An alternative system could be something like the Warabandi System of the northern States where each farmer within the command of an outlet, is allotted water in proportion to the ratio which the area of his holding bears to the total area under the outlet. The farmer has the choice of using the water during his span of allotted time on a smaller area and irrigate to a

greater depth, or spread the water on a larger area and irrigate to a lesser depth. He, therefore, has an incentive to make the water go as far as possible on his holding, consistent with the needs of the crops.

The State Government might also examine the feasibility of extending the Block System to areas in Vidarbha. The blocks may have to differ from those in western Maharashtra, in the sense that paddy areas will have to be isolated, and paddy blocks limited to low-lying areas where other crops would not normally grow. Kharif cereals, cotton and rabi cereals would be sanctioned in blocks for other areas.

Ayacut Development

We were unhappy to note that ayacut development, so essential for utilising the full irrigation potential of projects, was not receiving sufficient attention. No arrangements appear to have been made, for example, to develop the ayacut within the command of the Pench Dam, nor has it been taken up either in the Itiadoh or in the Jayakwadi Projects. In the ayacut of the Pench Project, a fair amount of land-levelling and land-shaping is called for and this work should be taken up well in advance of the release of the first irrigation water from the dam. The command area of the dam is 72,840 hectares and unless urgent steps are taken to develop the ayacut, the fullest benefits of irrigation will not be utilised speedily.

Itiadoh Project

This project has been under construction for quite some time. The dam has been completed, and the canals are under construction. It is unfortunate that the completion of the dam and the canals could not be synchronised, and delay avoided in commissioning the dam. We apprehend that there may be further delay in utilising the water fully, because no ayacut scheme has yet been formulated. The project engineers brought to our notice the fact that the completion of the canal system was inordinately delayed because the construction of a Railways bridge over the main canal alignment was stalled. We hope that such delays would be avoided in future.

The total live storage in Itiadoh reservoir is 227 m.cu.m. On the assumption that the 27,518 hectares under kharif paddy will need at least four irrigations in addition to rainfall, about 123 m.cu.m. of water will be used for paddy and the balance of 104 m.cu.m. of storage will have to be used for a second crop, after taking evaporation losses into account. We would recommend that further study should be done to assess the real, as against the notional, requirements of water for paddy irrigation during

the kharif season, so that more water may be made available for a second rabi crop.

Ramtek Tank

The Ramtek tank lies in a region where the rainfall is assured—100 cm to 130 cm. In the kharif season, therefore, paddy is the most suitable crop to which supplementary irrigation may be given from the tank, if the rains fail. We were given to understand that the duration of the paddy crop raised within the command of the tank is 120 days. We feel that if a short-term paddy maturing in 90 to 100 days could be substituted for the present strain, some water in the tank could be carried over to irrigate a rabi crop. This possibility should be examined. We noticed that field to field irrigation is practised in the ayacut and that no attempt has been made to provide field channels. We also found that no soil conservation measures have yet been taken up in the catchment, with the result that the rate of sedimentation of the tank is rather high.

Navegaon and Seoni Bandhs

The Navegaon and Seoni Bandhs are both ex-malguzari tanks which have been remodelled. The Navegaon Bandh was remodelled in 1967 prior to which it irrigated only 1,133 hectares. It now irrigates 4,210 hectares of paddy, 56 hectares of sugarcane and other perennials and 270 hectares of wheat. However, the irrigated area of 4,530 hectares is only 65 per cent of the culturable command of 6,900 hectares. We would suggest that the possibility of extending the area under irrigation by economising on the use of water for paddy should be examined. It appears likely that the paddy crop under the tank is being over-irrigated. The same considerations apply to the use of the waters of the Seoni tank. Here again, a study of measures to ensure the most economic use of water, so as to irrigate a second crop of rabi, is obviously called for.

Water Courses and Field Channels

We were informed that in Bhandara district irrigation is done from field to field for the kharif paddy, and that water courses and field channels had not been constructed. The more progressive among the farmers who met us, felt that water courses and field channels were very necessary, and one of them gave his opinion that if the department could be persuaded to construct field channels, the farmers would be quite prepared to bear the cost. We would stress the importance of providing water courses and field channels on all projects if waste of water is to be prevent-

ed. In any event, we would recommend that water courses and field channels be constructed in all new projects, as an integral part of the ayacut development. We consider that the field channels should be made compulsory in all projects, and that where any cultivator is unable, or unwilling, to construct them, the Canal Department or the Agriculture Department or the project authorities, as the case may be, should undertake the construction and recover the cost from the cultivators. To encourage farmers to take to new practices, particularly those relating to water management, the Irrigation and Agriculture Departments should draw up joint programmes for educating farmers in the correct use of irrigation water.

We gained an impression that sufficient attention is not being paid to the efficiency of irrigation. The full use or inadequate use of water appears to have been left to the discretion of the farmer. The Irrigation Department does not show much concern about it. We feel that the responsibility to maximise the duty for each ayacut should rest on the canal staff. The State Government should introduce a system of periodic checks of the duty in each project. The defaulting canal official responsible for a low duty should be adequately dealt with.

We would strongly recommend that the State Government should initiate long-term planning for the lining of all canals, except in reaches where such lining is not called for. Starting with the main canals, the programme should be extended, eventually, to branches and distributaries.

Jayakwadi Project

This is a large project for which the revised estimates have almost doubled from the original Rs. 384.6 million. The work on the main dam and on the canals is being done largely through departmental labour. The project authorities gave us to understand that they were able to control quality much better. Department work also avoids problems arising out of contractor's claims, whenever there was any change in design, or any new item of work introduced. The culturable commanded area of the project is 183,565 hectares and the irrigable area 141,640 hectares. The intensity of irrigation comes to 77 per cent. The major crops to be irrigated are cotton and rabi crops, but provision has also been made for growing rice on 5 per cent, sugarcane on 1.5 per cent of the command. In an area with rainfall below 75 cm, irrigated paddy requires heavy doses of water, and we strongly feel that this water would be better utilised in irrigating larger areas of cotton or rabi crops. Unless the areas allocated for rice are low and not suitable for dry-cum-irrigated crops, we would suggest that the irrigation of rice in the ayacut of this project should be prohibited.

We appreciate the fact that the growing of sugarcane and other perennials cannot be banned altogether, but it is also a fact that for the sake of irri-

gating the small areas under these crops, the whole canal system may have to be kept open. This contingency could, perhaps, be avoided by allowing these crops to be grown only within the command of a few selected channels, so that the rest of the system could be kept closed during March and April. Some device of this sort would save channel losses, and would incidentally provide time to carry out maintenance work on the main canal system. We noticed that the main canal has been lined but not the distributaries; if these distributaries could be closed for a couple of months each year, the lining of these distributary channels would be practicable.

During our discussions with the project authorities, we enquired if canal roads could be made available for general traffic. The reaction was unfavourable. One of the arguments advanced was that it would increase maintenance costs and the canal being a deep canal, it would be a safety hazard. We feel that this question needs further examination, because as a part of ayacut development, it would be beneficial if the main canal roads are thrown open to general traffic, so that link roads to villages and markets could be led off from these roads.

Miscellaneous

10.53 We were able to pay a visit to a farm, some distance from Nagpur, where a progressive farmer has grown orchard crops as well as food crops. We were particularly impressed by the efficient manner in which the farmer had supplied water to his orchards and to his fields through underground RCC pipe-lines. Control over the distribution of water was done through sluice-valves fitted at strategic points. The farmer had constructed two very large wells on his land, and had installed electric pumps on them for drawing water.

Lift Irrigation

10.54 We got the impression, during our discussions with the farmers, that there is considerable scope for lift irrigation, particularly from the Wainganga river and its tributaries. We consider that this question should be carefully examined by the State Government; and if lift irrigation is feasible, it should be taken up on a large scale, particularly as there are not much prospects of taking up any big project on the Wainganga.

Farm Machinery

10.55 The Minister for Irrigation brought to our notice that the irrigation programme of the State had been retarded by the ban on the import of heavy earth-moving machinery, on the ground that such machinery could be

procured indigenously. The internal production capacity, however, falls far short of demand and the Minister felt that the Government of India's policy in regard to the import of earth-moving machinery required revision.

He was particularly insistent on the need for a change in policy as the majority of dams being constructed in his State were earth dams for which earth-moving machinery was essential. He was apprehensive that Maharashtra's progress in constructing earthen dams would be seriously retarded, unless the import of heavy earth-moving machinery was permitted. We commend the Minister's views for the consideration of the Union Government.

One of the effects of the shortage of earth-moving machinery was the delay in ayacut development, wherever land-levelling or land-shaping had to be done. Since we consider ayacut development to be a necessity for all irrigation projects, its progress should not be retarded for lack of machinery.

Throughout the tour, we were given every possible assistance by the State and district officials. We greatly appreciated the frankness displayed by them and were impressed by their obvious interest and keenness to get the work done quickly and efficiently. Although in the past Maharashtra had lagged behind in the matter of irrigation, the pace of work in recent years has been remarkable. We hope that the proposals made above will be carefully examined.

CHAPTER XI

MANIPUR

Manipur is a small State on the Indo-Burma border covering an area of 22,330 sq.km. Out of this area, 20,590 sq.km. or 92.2 per cent are covered by hills and inhabited by the tribal population. Of the remaining 1,740 sq.km. of flat area, some portions are waterlogged and not suitable for cultivation. Two-thirds of the total population of about one million in Manipur is residing in the limited valley area of about 1,295 sq.km. Imphal, the capital of the State, is located almost in the middle of the valley.

11.2 The total area under paddy in the plains is about 0.1 million hectares and the average size of holdings is roughly one hectare. In addition to paddy, small areas are also under crops like sugarcane, rape, etc. Due to the pressure of population, almost all the available land is being utilised for cultivation. There is even encroachment on grazing land. The tribals are migrating from the hills to the plains in search of stable agriculture. The pressure on cultivated land is, therefore, heavy. The State is generally surplus in foodgrains but in a bad year, there may be deficit. There is, thus, need to increase production not only to meet the shortage but also the rising needs of the population.

11.3 There are no data available regarding the area cultivated under paddy and other crops in the hill areas. However, it is reported that there is scope for stabilising agriculture in these areas by providing irrigation facilities and by raising orchards and plantations. To meet the growing food requirements of people of the plains and of the tribals migrating there, irrigation is a necessity for stabilising the existing single crop of paddy and for raising a second crop. The rainfall in the plains ranges from 100 cm to 200 cm. Though sufficient for raising a single crop of paddy, there are areas in which successful cultivation is not possible either due to lack of timely rains or occurrence of floods.

11.4 So far no attempt has been made in the State for creating irrigation facilities. The thinking of the State Government appears to extend irrigation over the bulk of the valley. In the hills, it is proposed to divert

the small streams into irrigation channels and terracing rice fields to make them fit for irrigation water so that the tribals are gradually weaned away from jhuming.

11.5 The first project to be taken up in the State is the Loktak Multipurpose Project being constructed by the Union Ministry of Irrigation & Power. This project is designed to produce 105 MW of electricity and irrigate 24,280 hectares through pumped canals from the reservoir. Although the entire project including the irrigation portion has been approved in principle by the Government of India, so far provision of funds has essentially been made for the power side expected to be completed by 1973-74. With regard to irrigation, only a token provision of Rs. one million has been made and, that too, in the last year of the Fourth Plan on the presumption that power needed for irrigation will be available only by the end of the Fourth Plan. The construction of canals and distributaries for irrigation and the installation of the pump house would take about 3-4 years and unless this work is started almost immediately, the power available by 1973-74 could not be used for lift canals.

The cost of the irrigation portion of the project is estimated at Rs. 30 million for main canal and distributaries. This works out to only Rs. 1,235 per hectare. If the cropping intensity, which is to be 200 per cent, is taken into consideration, the effective cost of providing irrigation would work out to only Rs. 618/- per hectare. The low cost of providing irrigation is due to the proximity of command area. There would be no need for long canals, distributaries, etc. In view of the importance of the project to the area, the Commission recommends that the irrigation portion of the Loktak Project should be taken up immediately.

11.6 The cropping pattern proposed under this project is:

March to June	:	Paddy	12,140	hectares
		Nursery	6,070	,,
June to October	:	Paddy	18,210	,,
November to Feb.	:	Wheat	6,070	,,
,,		Mustard	2,020	,,
,,		Other crops	4,050	,,
		Total	48,560	,,

11.7 The State Government is anxious to cover the entire plains area with irrigation facilities for multiple cropping. There are no drinking water facilities in many villages and the extension of irrigation would

solve this problem. There is need for a detailed survey of the feasibility of extending irrigation.

11.8 No attempt has so far been made to provide irrigation facilities in the hills. It is reported that there is good scope for construction of diversion channels and terracing of rice fields with a view to providing stable agriculture to the tribals and preventing their migration to the plains. There is also scope for growing vegetables, orchards, etc. The sprinkler irrigation system may be helpful in utilising the water even on sloping lands without terracing. Wherever terracing is essential, the farmers should be given financial and other help for the purpose. Diversion channels can be taken up departmentally in the first instance and later the tribals encouraged to construct them.

11.9 The Commission recommends that detailed investigation of the feasibility of irrigation works including ground water exploitation be taken up. The Union Government should render all technical assistance required in this behalf.

CHAPTER XIII

MYSORE

The new State of Mysore came into being on the 1st of November, 1956 as a result of the reorganisation of the States, and was formed of the former Princely State of Mysore, and the Kannada speaking areas of the former States of Bombay, Hyderabad, Madras and Coorg. It lies in the western parts of the Deccan peninsula between 11.5° and 19° north latitude and 74° and 78° east longitude.

With an area of 1,91,773 sq. km. and a population (1971) of 29.26 millions it is the sixth largest State in the Union in size and the eighth in population. Against the all India density of 182 the density in Mysore is 153 persons per sq. km.

The State is divided administratively into four revenue divisions and nineteen districts. It is bounded on the north by Maharashtra and Goa, on the west by the Arabian Sea, on the south by Tamil Nadu and Kerala and on the east by Andhra Pradesh.

Physiography

13.2 The State consists of four distinct regions, (i) the coastal belt lying between the Western Ghats and the Arabian Sea, (ii) Malnad to the east of the Western Ghats, (iii) the northern plateau and (iv) the southern plateau.

Mysore's 320 km. long coastal strip is only 32 km. in width with an average height of 76 m. above mean sea level, though at some places the plain rises to 152 m. Because of the presence of a very large number of rivers, both big and small, flowing through it, its intersection by numerous small creeks and a number of hills, the belt presents many problems for communications and transport. These problems are intensified by very heavy and sustained rain during the south-west monsoon, averaging 254 cm. from June to August. The rainy season ranges from five months in the north to seven months in the south.

The predominant soil is alluvium in the plain and laterite on hill slopes. Because of the undulating and hilly character of the belt, there is a little scope for flow irrigation during the periods before and after the south-

west monsoons, when, except in the tidal reaches, the rivers are generally dry. Hydel stations can provide a perennial flow to give limited irrigation to limited areas. The rivers most promising for hydel power are the Sharavati, the Kalinadi and the Netravati. Rice is the main crop. Coconut and arecanut are also cultivated extensively.

The mean monthly temperatures range from 24°C to 31°C with high humidity and small differences between the night and day temperatures.

The land-locked Malnad area adjoining the coastal belt to the east, runs north to south for about 644 km with a width of 48 to 65 km. It is an area of forests and hills with a rugged topography, characterised by deep ravines and steep hills rising to heights of 1250 to 1890 m. which are the source of all the east and west flowing rivers of the State.

Malnad, like the Coastal Belt, gets heavy and assured rainfall, ranging from an average of 254 cm with peaks of 635 cm in the hills, to 105 cm in the east towards the plains. The mean monthly temperatures range between 18°C and 24°C which are normally lower than those on the coast. The soils are mainly laterites and on terraced fields paddy is the major crop followed by garden crops like coffee, arecanut and coconut.

The Northern Plateau drained by the Krishna, the Bhima and the Tungabhadra rivers is an extensive plateau with an average elevation of 610 m above mean sea level. The Krishna is the economic life-blood of the plateau.

With an average rainfall of only 61 cm or less, the plateau forms the most arid region of the State. Whatever rainfall it gets comes in torrential showers on five to ten days in each month during the south-west monsoons, with peak rain in September. The western margin has between 58 and 91 cm of rain while other areas get 40.6 to 91 cm. It is a region of hot summers and warm winters, where even the winter temperatures range between 22°C and 25°C and summer temperatures go up to 43°C. The landscape is monotonous, with vast areas of treeless fields on whose black cotton soils grow jowar, wheat and cotton.

The Southern Plateau was the core of the Princely State of Mysore and has a rolling topography with predominantly red soils intermixed with black soils. The rainfall is variable but not heavy, increasing from east to west. The area is drained by the three large rivers, the Cauvery, Tungabhadra and the Penner, of which the first two rise in the Western Ghats to flow eastward into the Bay of Bengal. The Cauvery is the most important river for the economy of the plateau.

Irrigation is from a large number of tanks dotted all over the plateau and the crops grown are rice and sugarcane. The bulk of the dry land is under jowar, bajra, ragi, castor and pulses. In the valleys, there are plantations of coconut and arecanut. Temperatures in the southern plateau are lower than those in the north and the rather scanty rainfall, 50 cm in the

north-west and 76.2 cm in the west, falls between April and November with the peak in October.

Climate and Rainfall

13.3 The climate of Mysore is a product of the interplay of the two opposing air masses of the south-west and the north-east monsoon and is essentially of the tropical monsoon type. The seasons are clearly marked, a short (January-February) cold weather is followed by three months (March to May) of hot weather. The south-west monsoon prevails from June to September and the north-east monsoon which sets in October continues till December. By far, the greatest part of the precipitation which averages 119 cm occurs during the period of the south-west monsoon. However, the range is very great, as high as 762 cm in the Western Ghats and as low as 38 cm in the eastern and northern parts of the State.

Table 13.1 shows the district-wise normal rainfall.

Table 13.1

District-wise Normals of Rainfall—Mysore

(m.m.)

District	South-west monsoon (June-Sept.)	Post monsoon (Oct.-Dec.)	Winter monsoon (Jan.-Feb.)	Summer or pre-monsoon (March-May)	Annual
1	2	3	4	5	6
Bangalore	407.5	215.2	11.8	159.1	793.6
Kolar	383.7	209.2	14.3	123.3	730.5
Tumkur	346.6	203.6	8.5	129.2	687.9
Mysore	308.5	233.5	10.4	209.5	761.9
Mandya	261.6	246.1	9.7	173.8	691.2
Hassan	612.7	244.5	10.4	173.1	1,040.7
Shimoga	1,209.0	192.3	5.3	119.7	1,526.3
Chikmagalur	1,575.7	245.6	7.5	161.0	1,989.8
Chitradurga	294.4	175.6	8.9	100.4	579.3
Bellary	344.1	144.0	6.5	80.3	574.9
Bidar	738.2	91.9	15.0	62.4	907.5
Gulbarga	532.5	103.1	12.6	54.1	702.3
South Kanara	3,401.5	332.0	6.0	192.3	3,932.4
Coorg	1,627.9	325.2	12.0	257.8	2,725.5
North Kanara	2,457.4	194.9	3.1	108.7	2,764.1
Belgaum	530.1	153.4	4.4	96.8	784.7
Bijapur	355.9	125.6	6.8	64.5	552.8
Dharwar	417.1	163.1	4.6	106.3	691.1
Raichur	424.5	115.9	6.9	54.3	601.6

Source: Memoirs of the India Meteorological Department, Vol. XXXI, Part III.

There are great variations, not only in the intensity of the rainfall but in its distribution. While in Malnad and the coastal belt the maximum rainfall occurs during the south-west monsoon with the peak in July, in the south-west portions of the southern plateau there are two peaks of rainfall—one in May, and the other and more important, in October. These are also peak rainfall months for the central and eastern portions of the southern plateau. The northern, central and north-eastern parts of the plateau, however, have the main peak in October and a subsidiary peak in May, except for the western margin of the northern plateau, which has one peak in July and another in October. The area generally has the maximum rain in September.

The map prepared by the Institute of Tropical Meteorology shows that 75 per cent of the State has a co-efficient of variability of more than 30 per cent. It has been found that the lower the rainfall in any given area, the greater are the chances of serious deficiencies, and the greater the deficiency the greater the risk of drought and famine. In discussing the question of variability the First Irrigation Commission observed that "a deficiency of 25 per cent would be likely to cause some injury and a deficiency of 40 per cent would generally cause serious injury". With a co-efficient of variability as high as 30 per cent, Mysore clearly falls within the category of areas exposed to a high degree of risk from drought and famine.

Soils

13.4 The soils of Mysore may be classified broadly into three groups, (i) black soils, (ii) red soils including red loams, red sandy soils and coastal red sandy alluvial soils, and (iii) laterites and lateritic soils.

The black soils are characteristic of north Mysore and occur extensively in the districts of Chitradurga, Belgaum, Dharwar, Bijapur, Raichur and Bellary. North of the Krishna river they are formed from the basic deccan trap rocks and elsewhere from schists and gneisses. In Dharwar, Bellary and Raichur these soils appear in valley bottoms, while in the same area red soils predominate in the uplands. Black soils are localised in a few taluks like Yelandur, Kollegal and Chamarajanagar.

The black soils of Mysore are typical of the soils originating from the weathering of basalts, schists and gneisses. Because of their ability to retain moisture, these soils are able to support a variety of crops even with the meagre rainfall in these areas. Cotton, the major cash crop and jowar, are widely cultivated and wherever irrigation is available, paddy and sugarcane are grown. Under rain-fed conditions, chillies, pulses and other dry crops can be successfully grown.

Red soils which are as typical of the southern plateau as black soils are of

north Mysore, occupy an extensive area in the districts of Bangalore, Kolar, Tumkur, Mysore and parts of Coorg, Hassan, Chickmagalur and Shimoga. In Dharwar, Belgaum, Raichur and Bellary districts, they occur along with patches of black soils. The rainfall in these areas is between 64-102 cm and the soil depth is between 0.9-1.5 m depending on the locality.

Depending on the extent of rainfall and the degree of temperature, a wide variety of crops can be grown. Under rain-fed conditions of dry farming, ragi is the main cereal crop. Where irrigation is possible, paddy and sugarcane are major crops followed by chillies, potatoes, onions, groundnut, ginger, tobacco and orchard crops. Where conditions are favourable, coconut and arecanut are also grown.

Red Sandy Soils are light textured, much shallower than red soils of which they are a variant, and have poor capacity to retain moisture. Because of the low rainfall, they are prone to salinisation and alkalisation, particularly in the valley. They occur in the northern parts of the Kolar and Tumkur districts, in the taluks of the Mandya district and in parts of Bangalore district. Where irrigation is available as, for example, in the command of the Visvesvarya Canal, paddy and sugarcane have been grown, and under well irrigation in Kolar district potatoes, onions and other crops do well. Under rain-fed conditions, ragi and other crops are widely grown.

The alluvial soils of the coastal belt, which consist of material washed down from the Western Ghats, are similar in properties to the red sandy soils, except that they are deficient in loam and acidic in reaction.

Laterite Soils occur along the Western Ghats in the heavy rainfall areas of Coorg, Hassan, Chikmagalur, Shimoga, South Kanara and in Malnad. They occur in patches in Bangalore and Bidar districts. Agriculture in areas covered by these soils, depends on the seasonal rainfall.

Land Utilisation and Cropping Pattern

13.5 The total geographical area of Mysore State is 19.18 million hectares. Details of land use are available for 18.96 million hectares of this area. The position regarding utilisation of land, in brief, during 1968-69 is as given below:

Out of the above, the total area under irrigation from all sources during 1968-69 was 1.23 million hectares as shown in Table 13.3. The net irrigated area as a percentage of the net sown area works out to 12.28.

It can be seen from Table 13.4 that jowar, rice and ragi, followed by groundnut and cotton, are the most important crops of the State. Most of the rice is irrigated from tanks. Jowar and ragi continue to be rain-fed, although of late, efforts have been made to provide irrigation to these crops too.

Table 13.2

Land Utilisation—Mysore

Item	Area in thousand hectares	Percentage of total
1	2	3
Total reporting area	18,957	100.00
Forest	2,824	14.90
Area not available for cultivation (a)	1,696	8.95
Other uncultivated land excluding fallows (b)	2,678	14.13
Fallow lands	1,710	9.02
Net sown area	10,049	53.00
Area sown more than once	506	—
Gross cropped area	10,555	—
Net irrigated area	1,234	—
Gross irrigated area	1,376	—

Note: (a) Area not available for cultivation includes area under land put to non-agricultural uses and barren and uncultivable land.

(b) Other uncultivated land excluding fallows includes area under permanent pastures and other grazing lands, land under misc. tree and groves, and cultivable waste.

Table 13.3

Area Irrigated—Source-wise (1968-69)

(Thousand hectares)

Source	Area	Percentage of the total irrigated area
1	2	3
Canals:		
(i) Government	441	35.74
(ii) Private	7	0.57
Tanks	351	28.44
Wells	317	25.69
Other sources (Pick-ups, jungle streams, ponds, thalaparíges, etc.)	118	9.56
Total:	1,234	100.00

Under rain-fed conditions in 1969-70, the average yield of jowar per hectare was 571 kg. The yield of rice on the average is 2,070 kg per hectare. Irrigation of jowar and ragi would certainly give increased yields.

Table 13.4

Area under Principal Crops in Mysore—1968-69

Crop	Area in thousand hectares	Percentage to cropped area
1	2	3
Rice	1,113	10.5
Jowar	2,535	24.0
Bajra	544	5.2
Ragi	959	9.1
Wheat	326	3.1
Other cereals and millets	511	4.8
Total cereals and millets	5,988	56.7
Total pulses	1,324	12.6
Total foodgrains	7,312	69.3
Sugarcane	106	1.0
Condiments and spices	189	1.8
Fruits and vegetables	139	1.3
Other food crops	36	0.3
Total food crops	7,782	73.7
Groundnut	933	8.9
Other oilseeds	467	4.4
Total oilseeds	1,400	13.3
Cotton	948	9.0
Other non-food crops	425	4.0
Total non-food crops	2,773	26.3
Total cropped area	10,555	100·0

Surface Water Resources

13.6 There are seven rivers with their tributaries, which drain the State. Their names and the areas drained are given in Table 13.5.

Table 13.5

River Systems of Mysore

River System	Drainage area lying in Mysore State (thousand sq.km.)	Percentage to the total area of State
1	2	3
Krishna	113.01	58.93
Cauvery	36.13	18.84
Godavari	4.43	2.31
West flowing rivers (Netravati, Sharavati, Kalinadi, etc.)	24.53	12.79
North Penner, South Penner (Ponnaiyar), Palar	13.67	7.13
Total:	191.77	100.0

77.77 per cent of the geographical area of the State is drained by the Krishna and Cauvery.

Krishna Basin

The Krishna rises in the Western Ghats at an altitude of 1,336 m just north of Mahabaleshwar in Maharashtra State about 60 km east of the Arabian Sea. It flows across the entire width of the peninsula for 1,400 km through Maharashtra, Mysore and Andhra Pradesh to empty itself into the Bay of Bengal. The Krishna's course for 362 km lies in Mysore State. Its major tributaries are the Bhima, the Koyna, the Panchganga, the Dudhganga, the Tungabhadra, the Hiranyakeshi, the Ghatprabha, the Malaprabha and the Vedavati. Except for the Koyna and the Panchganga, all these tributary rivers flow through Mysore State.

The Tungabhadra which has a drainage area of 66,237 sq. km. is the largest and most important of the Krishna's tributaries. It rises at an altitude of about 600 m just north of Shimoga and is born of the union of two rivers, the Tunga and the Bhadra which both rise in the Western Ghats.

The Tungabhadra flows for about 531 km in a north-easterly direction in Mysore and Andhra Pradesh before it joins the Krishna beyond Kurnool. The river's course lies for 402 km within the boundaries of Mysore State. The Varada and the Vedavati are the most important tributaries of the Tungabhadra.

Nearly 60 per cent of the area of Mysore State lies in the Krishna basin and covers parts of 14 of the 19 districts in the State. The cultivable area of the basin is about 9.28 million hectares of which 0.56 million hectares is irrigated, which is a mere 6 per cent of the total cultivable area.

Cauvery Basin

The river Cauvery has its origin in the Western Ghats in Coorg district. Before it empties itself into the Bay of Bengal, it flows for a total length of 804 km through the States of Mysore and Tamil Nadu forming the boundary between these States for a length of 53 km. Of its total length, 310 km lie in Mysore State. Its major tributaries in Mysore are the Hemavati, the Lakshmanatirtha, the Harangi, the Kabbani, the Suvarnavati, the Lokapavani, the Shimsha and the Arkavati.

The major contributions to river Cauvery flows come from catchment areas in the districts of Bangalore, Chikmagalur, Coorg, Hassan, Mandya, Mysore and Tumkur, the annual rainfall in the hilly catchment being 508 cm per annum and in the plains 51 cm.

Of the 2.405 million hectares of cultivable land in the basin a mere 5.8 per cent or 0.14 million hectares is irrigated.

Godavari Basin

A major part of the Bidar district lies in the basin of the Manjira, a tributary of the Godavari. Its catchment area in Mysore State is 4,434 sq. km. Of the cultivable area of 490 thousand hectares in Bidar district, only 79 thousand hectares or 16 per cent of the cultivable area is irrigated mostly by wells.

North Penner, South Penner and Palar Basins

These three rivers drain about one-fifth of Tumkur district, nearly one-third of Bangalore district and the whole of Kolar district. 8.05 per cent of the 1.05 million hectares of cultivable land in the catchment of these rivers is irrigated mostly through the numerous tanks which are a feature of the region. Though there are possibilities for the extension of tank irrigation, there is little scope for major or medium projects.

West-flowing Rivers

There are a number of rivers such as the Sharavati, the Kalinadi, the Gangavali, the Aghanashini and the Netravati, which rise on the western side of the Ghats and drain into the Arabian Sea through the districts

of North and South Kanara, Shimoga and Coorg. As mentioned in paragraph 13.2, the area is unsuitable for irrigation from canals.

The current extent of irrigation is 12.02 per cent of the total cultivable area of 1.11 million hectares.

Ground Water Resources

13.7 Because the plateau areas of the State are underlain by crystalline rocks, conditions for the creation of ground water aquifers are generally very poor. However, an alleviating factor is the presence, almost all over the State, of a mantle of loose soil and decomposed rocks which ranges in thickness from a thin film to layers up to 30 m thick. The average thickness of this soil mantle is about 15 m and it is the porous material in the mantle which acts as a ground water reservoir, holding from $\frac{1}{4}$ to 3 gallons per cubic foot.

Though, recently, some bore wells of 15.24 cm diameter have been drilled, the ground water reservoir has hitherto been tapped through shallow open wells. Studies of the behaviour of the water-table have shown that it is high towards the end of October, and progressively declines, till it reaches its lowest in March and April. In those months a large number of open wells fail. Once the rains commence in June, the level slowly begins to rise. The levels of the water-table in the State fluctuate from 2.5 m to 3 m though in hilly terrain, or where the decomposition of the underlying rocks has extended to considerable depths, the difference between levels can be as much as 18 m to 24 m. These high variations are particularly common in Malnad.

In 1968, a Ground Water Cell was set up in the State's Department of Mines & Geology to survey the ground water resources of the State, to collect basic data, and to advise on the utilisation of ground water. The data cover the following:

(i) Rainfall, topography, soil characteristics;

(ii) ground water availability in existing dug wells and drilled wells—inventory of wells in each district;

(iii) depth of water-table in different rock formations, seasonal fluctuations in water-table; rate of lowering at a given rate of pumping;

(iv) preparation of water-table, contour map on the basis of data collected for selected areas;

(v) collection of information on run-off characteristics of not only major rivers but also minor schemes;

(vi) estimation of ground water potential of individual stream basins;

(vii) geophysical study to estimate depth of weathering and depth of water-table and of bed rock;

(viii) studies on the quality of water; and

(ix) formulating plans for construction of open and drilled wells, locating sites and prescribing minimum safe spacing, to avoid mutual interference.

A map for each taluk of the State is under preparation showing the area of likely ground water potential. The State Government is also thinking of getting similar maps prepared for each village. We were told that the cell does not have a full complement of geo-hydrologists and we are of the opinion that the matter may be looked into. We would also like priority to be given to drought-affected areas in selecting areas for ground water exploitation.

One of the matters which we would like the Mysore Government and other State Governments which have large drought-affected areas to examine, is the institution of an insurance scheme to compensate the farmer if his well fails during construction. We understand that in such cases the State Government forgoes the recovery of a part of the loan, but in our opinion this is far from satisfactory. The insurance scheme should be optional and any farmer, who intends to dig a well, may on payment of a premium take out an insurance policy which would, in case his well fails, enable him to get compensation to the extent of the sum assured. Since ground water resources in the drought-affected areas are uncertain, such an insurance would cover the risks incidental to the sinking of wells.

A preliminary assessment of the ground water potential of the State, based on the supposition that nearly 10 per cent of the rainfall goes to recharge the aquifers, indicates that about 18,500 m.cu.m. (15 MAF) of water go to this recharge.

Present Stage of Development of Irrigation

13.8 Figures of irrigation for the old State of Mysore, as it was constituted in 1901, are not available. However, on the basis of a rough assessment by the State Government it appears that out of a total cultivated area of about 7.68 million hectares, about 0.5 million hectares were irrigated in 1901. There were at the time no major reservoirs or any large-scale system of canals, though there were many small canals which commanded limited areas. The position in 1901 is reproduced in Table 13.6.

The Famine Commission of 1878-1880, and the First Irrigation Commission, both recognised the importance of the Tungabhadra river as a major source of irrigation water for the drought-affected district of Bellary. The two Commissions realised, however, that not much could be achieved without a storage on the Tungabhadra, and while recommending such a storage, they made it clear that any storage scheme would be extremely costly. The recommendation about the execution of schemes was not implemented till 1945. Nevertheless, work on the Krishnarajsagara Project

Table 13.6

Source-wise Irrigation in Mysore—1901

Source	Area in hectares
1	2
Canals	56,241
Tanks	2,59,742
Wells	60,349
Other sources	1,27,530
Total:	5,03,862

for the erection of a dam across the Cauvery, recommended by the First Irrigation Commission, to store 1,218 m.cu.m. of water for irrigating 20,200 hectares of land in the districts of Mysore and Mandya, was taken up by the Maharajah of Mysore and completed by 1930.

The Tungabhadra Project was started in 1945 and the dam was completed and irrigation commenced in 1953. Of its two canals, the low-level left bank canal irrigates areas entirely within Mysore State, while the right bank canal irrigates areas in Mysore as well as in the adjoining State of Andhra Pradesh. The aggregate area irrigated by both canals in Mysore is 0.27 million hectares.

The First Irrigation Commission commented favourably on the vigorous and liberal taccavi policy of the then Government of Madras. In every district visited, the Commission was told by witnesses almost unanimously that irrigation from wells had considerable scope for development. They recommended the advancing of liberal taccavi loans, and suggested measures for prolonging the period of repayment, reduction in interest rates, and lowering the level of officers empowered to grant loans.

Details of the assistance given by the Mysore State for the improvement of tanks and wells are not available. But the fact that the increase in irrigated area between 1901 and 1951 was only of the order of 0.18 million hectares, is enough to show that whatever help was given to the farmers to extend irrigation from tanks and wells was very inadequate.

Irrigation in Mysore, as in many other States in India, received an im-

petus with the advent of the Five Year Plans, and in the past twenty years, a number of major and medium schemes were taken in hand which have increased the irrigated area to 1.23 million hectares by 1968-69. The break-up of the area, source-wise, is shown in Table 13.3.

13.9 A brief description of important projects taken up since 1945 is given below:

Tungabhadra Project

Numerous big tanks and irrigation works in the Tungabhadra region existed as far back as 1369 during the reign of Prince Bhaskara of the first Vijayanagar dynasty. For nearly 300 years, this great river was the final line of defence of the Hindu Rajas of the Deccan against the incursions of Muslim Sultans from Delhi, and in 1565 when the city of Vijayanagar was over-run and destroyed, the tanks and irrigation works on the Tungabhadra shared the fate of the Empire.

In 1800, the Nizam of Hyderabad ceded the area to the south of the river to the East India Company, and it formed the boundary between Madras and Hyderabad States till 1953.

The waters of the Tungabhadra flow from the Western Ghats through areas of the Deccan, which have for long lived in the shadow of drought and famine. The districts of Rayalaseema in Andhra Pradesh and of Raichur in Mysore are areas where the uncertainty of rain makes agriculture precarious. The then Madras Province proposed a storage reservoir on the river to the First Irrigation Commission. The Commission approved of the proposal, and opined that water from the reservoir should be shared between the Princely State of Hyderabad and the Province of Madras. Unfortunately, for nearly 40 years, Hyderabad and Madras could not agree on the sharing. A final agreement could be reached only in 1944. Under the agreement, it was decided that the Province of Madras and the State of Hyderabad could each draw 1,841 m.cu.m. (65 TMC) for irrigation. The construction of the project was started on the last day of February, 1945.

The Tungabhadra dam is a unique example of a dam whose construction was started from the opposite banks of a river by two separate Governments, two separate groups of workers, two separate Chief Engineers, and two separate cadres of Engineers. In spite of the many stresses and strains inherent in a project burdened by an arrangement of this nature, the dam was completed in 1953 and the first irrigation was done through the right bank low-level canal that year. The full irrigation potential has now been achieved.

The formation of Andhra Pradesh in October 1953 involved the transfer

of the areas to the south of the river in the States of Mysore and Andhra. The western half most of it in Bellary district, went to Mysore and the eastern half to Andhra. A further redistribution took place in November 1956, at the time of the reorganisation of the States, when substantial portions of Hyderabad territory north of the river were transferred to Mysore. As a result the dam, the whole of the left bank canal and the upper reaches of the low and high level right bank canals fell to the share of Mysore, while the lower reaches of the latter went to Andhra Pradesh.

The Tungabhadra Board was formed to administer the project in so far as the dam and the upper reaches of the right bank canal were concerned. The Union Ministry of Irrigation and Power appoints the Chairman of the Board, one Chief Engineer for civil and the other for electrical works on the Board.

The dam is 2,441 m long and 49.4 m high above the deepest foundation. A length of 700 m in the middle of the dam functions as a spillway. The gross capacity of the Tungabhadra reservoir is about 37.67 m.cu.m. (3.05 MAF).

The left bank main canal flows for the entire length of 226 km in the Raichur district, for the first 30 km through hilly country strewn with the ruins of the once great Vijayanagar empire. The canal passes through two subsidiary reservoirs, one at Sanapur and the other at Shivapur, before it enters the open country through a tunnel. This tunnel is 1,084 m long, 6.7 m wide and 5.8 m deep.

In the reach up to the 24th km, the canal has been designed to carry a discharge of 198 cumecs for the development of power. Thereafter, it carries 88 cumecs for irrigation and the balance goes back to the river to serve riparian owners lower down the Tungabhadra. The canal is lined throughout its length.

The Low-level Right Bank Canal, known for its first 22 km as the Power Canal, runs through very rough terrain for about 10 km. At Hampi there is a drop of 33.5m which is used for the development of power. Thereafter, out of the total discharge of 71 cumecs, 20 cumecs are led into the river so that the low level canal carries its designed discharge of 51 cumecs. The canal, which is unlined, runs for 227 km in Mysore territory and then for the remainder of its length of 98 km, it irrigates the Kurnool district of Andhra Pradesh.

Opened for irrigation only in 1967, the high-level right bank canal is 195 km long and is designed for a head discharge of 113 cumecs. It enters Andhra Pradesh after flowing for a distance of 109 km in Mysore. Work on lining the canal is in progress.

Sanctioned at an estimated cost of Rs. 975.7 million, the project is designed to irrigate 0.35 million hectares in Mysore and 0.17 million hectares in Andhra Pradesh. In the utilisation of water and the development

of irrigated agriculture, the progress has been uneven. Development of the areas served by the right bank low-level canal has been much more rapid than that of the areas served by the left bank canal. The actual area irrigated by these two canals is as follows:

Table 13.7

Area Irrigated by the Tungabhadra Project—Statewise

(Thousand hectares)

Name of Canal	Mysore		Andhra Pradesh	
1	2		3	
Left bank low-level canal Right bank low-level canal	210.00	(1970-71)	37.85	(1971-72)
Right bank high-level canal	16.00	(-do-)	30.63	(-do-)
Total:	226.00		68.48	

Bhadra Reservoir Project

The project comprises a masonry dam across the river 444.44 m long and 59.13 m high above the average bed level of the river, with two canals serving the scarcity affected areas of Chikmagalur, Shimoga, Chitradurga and Bellary districts. The left bank canal irrigates an area of 7,020 hectares and the right bank canal with three branch channels irrigates an area of 91,300 hectares.

Ghatprabha Project

The dam is being erected at Hidkal on the Ghatprabha with two canals, one taking off from the left bank of the existing weir at Dhupdal and the other taking off on the right bank of the dam. The canals will each irrigate 0.12 million hectares of land.

The work on the main dam is progressing well, and the remodelling and extending of the left bank canal is practically complete. The available run-of-the-river supplies are now being fully utilised. The issue of sharing the Krishna waters is now pending before a special Tribunal set up by the Government of India and the sanction for constructing the right bank canal on the Ghatprabha has to await the Tribunal's decision on the main issue. The final stage of the Ghatprabha project envisages the construction of a high-level left bank canal taking off from the Hidkal dam.

Malaprabha Project

This project, which began in the Third Plan period, is expected to provide irrigation to about 0.2 million hectares on both sides of the river in the scarcity affected areas of Belgaum, Bijapur and Dharwar districts.

Kabini Reservoir Project

This project envisages the construction of a dam across the river Kabbani, a tributary of the Cauvery to irrigate about 51,000 hectares in the Heggadadevanakote taluk of the State, through its canal system.

Hemavati Project

This project consists of a dam about 48 m in length, across the river Hemavati, a tributary of the Cauvery near Gorur in Hassan district. The dam which will store 651 m.cu.m. of water will irrigate about 40,500 hectares in the precarious districts of Hassan and Mysore. Though the project still awaits clearance from the Planning Commission, the State Government is reported to have taken up work in anticipation of this clearance.

Upper Krishna Project

Before the formation of the present Mysore State, the former Bombay State had formulated a proposal to provide irrigation in Bijapur district from the river Krishna. The former Hyderabad State had also investigated a project for the construction of a storage dam and canals, to irrigate the Raichur and Gulbarga districts from the same river. These projects after being recast have taken the shape of the present Upper Krishna Project in Mysore and the Lower Krishna Project, now called the Nagarjunasagar Project in Andhra Pradesh.

In the Upper Krishna Project, two dams are to be constructed to impound the waters of the Krishna, one at Alamatti and other at Narayanpur. The complete project will utilise 12,516 m.cu.m. of water to irrigate 0.89 million hectares in Bijapur and Raichur districts. The first stage of the project comprises the construction of the Alamatti dam up to the foundation level, and the completion of the Narayanpur dam and the Narayanpur left bank canal to utilise 2,917 m.cu.m. of the waters of the Krishna, to irrigate 0.24 million hectares. The original estimate of Rs. 530 million for Stage I has been revised to Rs. 1,040 million. The pattern of irrigation has been recast by reducing the area under paddy and increasing the area under other crops.

Minor Irrigation

13.10 Minor irrigation plays an exceedingly important part in Mysore with its magnificent series of small tanks. No less than 0.79 million hectares of the State's area are covered by tanks, wells and other minor sources of irrigation. These works irrigate 64 per cent of the total 1.23 million hectares irrigated in the State.

The minor irrigation works, except wells dug by farmers, are generally constructed by the Government and include tanks and pick-ups. About Rs. 1,360 million have been spent in the first three Plans and the three Annual Plans on minor irrigation. These works have added 0.15 million hectares to the area under irrigation.

There were 180,000 wells in existence in 1951 at the beginning of the First Plan Period. That number has now gone up to 300,000 of which about 130,000 wells are fitted with pumps and 97,000 have been energised. The State Government proposes to energise another 100,000 pumps by the end of the Fourth Plan.

Since the Famine Commission of 1878-1880 highlighted the critical role of tanks in the ceaseless battle against drought, the importance of this source of irrigation has never been denegraded. Referring to the then Province of Madras, parts of which are now in Mysore State, the First Irrigation Commission stated that out of 40,000 small river channels and tanks which comprised the main sources of irrigation, tanks alone accounted for 30,000. The Commission also drew attention to the fact that the restoration of tanks had been a major State policy ever since 1883 and recommended that the expenditure on the restoration and maintenance of tanks should be greatly increased.

The Commission made several suggestions to improve the administrative machinery dealing with the restoration and maintenance of tanks, and to ensure the progressive development of this type of irrigation. It stressed the inculcation of a spirit of self-help and self-reliance on the part of the cultivators, who were to be encouraged, not only to extend tank irrigation by constructing new tanks, but also to keep existing tanks in good shape.

It is no wonder, therefore, that tanks continue to be so prominent and unique a feature of the Mysore topography, although it must be recognised that efforts to persuade cultivators to take up construction of tanks on their own have not been successful, and the vast numbers of tanks still continue to be constructed, maintained and restored by the State.

Tank construction in Mysore is greatly assisted by the lie of the land. They are often constructed 'en echelon' i.e. in series, one below the other so that the overflow of one tank is collected by the tank next below. These tanks continue to be the mainstay of cultivation over large parts of the State.

Administratively, the State Public Works Department is in charge of the maintenance and repair of all tanks with an ayacut of more than 100 hectares, while smaller tanks are the responsibility of the Revenue and Agriculture Departments through Taluk Development Boards.

Possibilities of Future Development

13.11 According to the estimate of the State Government, an area of 3.4 million hectares can be brought under irrigation if Mysore utilises 40,493 m.cu.m. of Krishna waters. They have estimated that irrigation from the Cauvery can be extended to another 0.17 million hectares.

The other east-flowing rivers, which water Mysore State, are the North and South Penner, and the Palar. The only project proposed on the North Penner is the Uttarpinakini Project which is expected to utilise 15.m.cu.m. to irrigate 1,454 hectares. In the catchment of these three rivers, future development will largely be confined to the construction of minor irrigation works.

According to the State Government the irrigation potential of the west-flowing rivers is rather limited, and it is possible to irrigate only 0.05 million hectares from these rivers.

The total irrigation potential of surface water resourcess according to the State Government is given below:

Basin	Area in thousand hectares
Krishna	3,394
Cauvery	810
Godavari	108
North Penner etc.	87
West-flowing Rivers	179
Total :	4,578

Floods, Waterlogging and Drainage

13.12 The State is free from any serious problem of floods.

However, with the construction of canals in some areas the problem of waterlogging has arisen, though it has not assumed any serious proportions. The area affected by waterlogging is given in Table 13.8.

Table 13.8

Area subject to Waterlogging

(Hectares)

Project	Total area irrigated	Area water-logged	Percentage of area affected
1	2	3	4
Ghatprabha L. B. Canal	52,610	1,640	3.12
Gokak Canal	6,810	290	4.26
Tungabhadra L. B. Canal	234,720	2,025	0.86
Tungabhadra R. B. Canal	40,470	610	1.51
Bhadra Project	97,125	2,025	2.08

The only step taken so far to study the subsurface regime of water is to record water-table observations in some command areas of major projects like the Ghatprabha.

In Mysore, no provision for drainage appears to have been made in various irrigation projects. It was reported to us that about 2,800 hectares of land in the Bhadra Project had been affected by salinity and alkalinity and that the area of such land was on the increase. This matter requires the attention of the State Government before the problem assumes threatening dimensions.

It was also represented to us that the causeways across many drains have obstructed free flow and this is giving rise to the evils of waterlogging, salinity etc. We understand that the State Government has prepared a programme of improving the surface drainage, cutting channels in silted-up nallahs, and putting up closed-type drains. Some pilot studies on these lines have been initiated in the Krishnarajsagara command. For the future it is intended to provide drainage in all irrigation projects.

In the Upper Krishna Project, the canals and distributaries are all proposed to be lined. In the Tungabhadra Project, only the left bank canal and the high-level right bank canal have been lined. In Chapter VI of the First Volume of our Report 'Policies and Considerations in Irrigation', we have dealt with the problem of lining of canals, and have recommended that in all future projects the main canals and branches should generally be constructed as lined channels, though the lining of distributaries may be done when more resources become available.

In this connection our observations under the sub-heading 'Irrigation Policy for Drought Affected Areas'* would need the attention of the

*Page 175 of Volume I.

State Government. In regard to the existing irrigation systems on page 196 of Volume I, we have recommended the lining of selected reaches of the major elements of the distribution system. Since more than half the geographical area containing nearly half the population is drought affected, the necessity to save water in Mysore is a prime need.

We recommend that the policy of lining canals and branches may be followed in the future. The existing irrigation works should be subjected to an immediate review to identify selected reaches for lining.

Water Rates

13.13 Water rates in the State are assessed according to the provisions of the Mysore Irrigation (Levy of Betterment Contribution and Water Rates) Act of 1957 and the Mysore Irrigation (Levy of Water Rates) Rules of 1965. The rates under the Act and Rules range from Rs. 3/- per acre in the case of manurial crops like sunhemp or sesbania, to Rs. 45/- per acre in the case of sugarcane. A provision has also been made for the levy of water rates on a second crop.

Two sets of rates have been prescribed in the Rules, one in respect of irrigation from works capable of irrigating less than 40.46 hectares (100 acres) and the other and a higher rate for irrigation from works capable of irrigating more than 40.46 hectares (100 acres).

During our discussions with the Chief Minister on methods for increasing the financial returns from irrigation projects, he pointed out that it would be desirable to have a more or less uniform policy for the fixation and recovery of water rates throughout India. He said that if a State Government raises water rates or betterment levy to a level higher than that prevailing in neighbouring states, it gives legitimate cause for discontent to the irrigators of the State where the rates are raised. We see considerable force in this contention. On page 278 of the First Volume of our Report we have recommended that the water rates should be reviewed and raised by all States of the Union in the fourth year of every Plan. We have also made recommendations laying down guide-lines for the fixation of water rates, particularly on pages 268 and 269. These, we hope, will introduce a general uniformity in water rates all over India.

Betterment Levy

13.14 The Mysore Irrigation Act and Rules of 1965 provides for the levy and collection of a betterment contribution from the holder of any land which is benefited by the construction, restoration and extension or alteration of any irrigation work. Lands under public works irrigating 40.46 hectares (100 acres) or less are exempt from the levy. The rate of the

levy is equal to one-half of the difference between the market value of land prior to the completion of the work, and that after completion, subject to a ceiling of Rs. 500/- per acre. The cost of improvements made by the landlord is excluded in calculating the increase in market value.

The contribution may be made either in cash, or wholly or partly by surrendering land of equivalent value. When paid in cash it is payable in twenty annual instalments.

Some Observations Based on Tours

13.15 We toured in Mysore State from 5th to 13th August 1970, and visited the commands of the following projects:

(i) Ghatprabha
(ii) Upper Krishna
(iii) Tungabhadra
(iv) Bhadra
(v) Hemavati
(vi) Krishnarajasagara

A large number of people including M.Ps., M.L.As., district officials and progressive farmers met us and explained the problems of irrigation development. The Chief Engineers, Irrigation, Divisional Commissioners and the Director of Agriculture and several other district officers accompanied the Commission within their jurisdictions. At numerous places representations asking for the early completion of projects in hand or for providing new facilities of irrigation were handed over to us. The meetings held at Dhupdhal, Jamkhandi, Indi, Sindigi, Jevargi, Lingasugur, Raichur, Tungabhadra Dam, Harihar, Bhadravati, Hassan and Mandya were largely attended. Finally we held discussions at Bangalore on 12th August with the Chief Minister and his colleagues and on 13th with the Development Commissioner and other senior officers of the Government.

13.16 Of the projects visited by the Commission, Krishnarajasagara is a pre-Independence project in full operation. The two other projects, namely, the Tungabhadra and Bhadra reservoirs, have been completed in the post-Independence period. The remaining three projects, namely, the Ghatprabha (2nd stage), Upper Krishna (1st stage) and Hemavati are under construction.

We found that there has been inordinate delay in the completion of projects in the State. For instance some projects which were taken up in the Third Plan may have to spill over to the Sixth Plan. It appears that the State has taken up too many projects without making arrangements for adequate finances. Even some projects which had not received the clearance of the Union Government were taken up. We would like the State

Government to carefully examine the question of the financial resources needed for the speedy completion of the projects under construction and endeavour to complete them within the Fifth Plan period perhaps with the exception of the Upper Krishna. If, however, adequate funds are not available, the State Government should allocate funds so that priority projects may be completed within the Fifth Plan.

13.17 We regret that we cannot support the policy of starting irrigation projects for which the State is unable to find adequate funds. We would like the State Government to review the position of projects under construction and to give a higher priority in the matter of allocating funds to projects which have reached an advanced stage of construction. The balance of annual allocations may be distributed over the other projects in such a manner as to enable them to be completed at the earliest. No new project should be started unless a sufficiently large number of projects now under construction have been completed and the starting of new works becomes necessary to keep up the tempo of construction activities in the State.

13.18 The then Chief Minister of Mysore suggested that all major projects costing more than Rs. 100 million should be financed by the Centre outside the Plan allocations of the State. After giving careful consideration to the proposal, we have made our recommendations in this regard on pages 258 and 259 of the First Volume of the Report. These are to the effect that at the time of according approval to large irrigation schemes, irrigating say, over 0.2 million hectares, it should be examined whether the State Government is in a position to execute the schemes at the optimum pace. If not, the States should negotiate with the Union Government for special financial arrangements for the scheme.

13.19 At a number of places in the Ghatprabha area, complaints were made to us by the local people that the Government of Maharashtra was planning to divert westward the flows of the river Ajra which now flows eastwards. They pointed out that before the reorganisation of the States (1956), the Maharashtra Government had itself worked out a plan to use the Ajra waters in the Ghatprabha area when it was a part of Maharashtra. The mere transfer of territory from one State to another within the Union, they said, should not alter the merits of the use of the water of the Ajra in the Ghatprabha area, particularly as the area was drought-affected.

In paragraph 5.22 of the First Volume at page 90, we have recommended that normally the use of water for irrigation should have priority over its use for the generation of power, especially when the area to be irrigated is prone to drought. We were told that Maharashtra wants to divert the

Ajra waters for generating electricity. This would be contrary to the policy enunciated by us. If, however, the water of the Ajra river is needed by the Maharashtra Government for irrigating the Konkan area, the matter would deserve consideration.

13.20 The pride of place in highlighting the importance of ayacut development goes to the Tungabhadra Project in Mysore State. This happened because the slow progress in the utilisation of the Tungabhadra Project water had become the subject of criticism at the Centre and in the State. The project authorities deserve credit for quickly analysing the causes of delay and for finding an effective solution. What was done in the Tungabhadra ayacut development was repeated with greater intensity in the development of the Nagarjunasagar Project.

In Chapter VII of Volume I—'Ayacut Development', we have dealt in detail with the problems responsible for delays in the development of ayacuts. We have dealt with the composition and functions of the co-ordinating machinery for development, the nature of the development agencies and services, soil surveys, consolidation of holdings, construction of field channels, land-levelling and land-shaping, selection of cropping pattern, research on crops and plant-soil-water relationships and the need to develop the infrastructure—roads, communications and markets. We have also dealt with financing and the agencies for making funds available for ayacut development. A plan of ayacut development should be prepared simultaneously with the investigation of the engineering part of the project.

13.21 In the Tungabhadra Project, the localisation of crops to obtain the maximum production per unit of water has been tried. Under the sub-heading 'Free choice of cropping—block system—localisation', the Commission has dealt with the system of the localisation of crops which has, for the first time, been tried in the South. On pages 140-141 of Volume I, we have dealt with the faulty localisation of rice on light soils in the higher reaches of a valley which gives rise to the problem of excessive seepage and waterlogging in the heavier soils below. We would like the State Government to carefully examine the matter and to remove the defects in the system of localisation in the light of our remarks.

13.22 In Mysore State, according to our assessment, at least 54 per cent of the total geographical area inhabited by nearly one half of the people of the State, falls under the category of drought-affected areas. The State Government had identified 117 taluks of the 16 districts in the State as being drought-affected. According to the criteria laid down by us, only those areas which have a seasonal rainfall of 400 mm or less during the kharif, of 150 mm or less during the rabi, a rainfall availability of

more than 30 per cent during the crop seasons and rainfall deficiencies of more than 20 per cent during the crucial stage of the crop growth, ordinarily come under the definition of drought-affected areas. In any drought zone—(i) those areas where 30 per cent or more of the crop area are irrigated; and (ii) those areas which comprise only a small portion of the district with an adequate rainfall or irrigation, are excluded from this category. As a result, the Commission has accepted only 88 taluks from 12 districts as being drought-affected (vide Appendix 13.1).

The average level of irrigation obtaining at present in the 12 drought-affected districts is only 10 per cent. However, it is possible to provide lift irrigation to large parts of these areas by harnessing the river flows. A number of irrigation schemes (vide Appendix 13.2) have been undertaken by the State after Independence but most of them have been delayed in construction. There is ample scope for taking up new projects (vide Appendix 13.3), some of which have been held up because of the dispute on the division of the waters of Krishna and Godavari pending before the Inter-State Tribunal. We are of the opinion that the water disputes of the Krishna and Godavari call for urgent settlement, in which the Union Government can play the effective role suggested by us in the penultimate portion of Chapter XV (Inter-State River Disputes) in the First Volume of the Report.

CHAPTER XIV

NAGALAND

Nagaland was carved out of Assam in December 1964. It consists of three districts, Kohima, Mokokchung and Tuensang. It is located in the eastern most part of India and lies between latitude 25°6′ and 27°4′ N and longitude 93°20′ and 95°15′ E. The State has common boundaries with Assam in the north and the west, with Arunachal Pradesh and Burma on the east. The geographical area of the State is 16,488 sq.km.

The population of Nagaland, according to 1971 census is 0.52 million. The State is sparsely populated having only 31 persons per sq.km. against 182 for India as a whole.

14.2 The main occupation of the people is agriculture, 90 per cent of the population depend upon it for their living. The rest of the population is engaged in tertiary activities, principally of services.

14.3. Most of the area is hilly with mean elevation ranging between 150 and 3,000 metres above MSL. Generally the hills form serrated ridges separated by deep valleys, through which streams or rivers flow to the plains in the north. The hills in the south (Kohima) have steeper slopes while those in the central part of the State (Mokokchung) are gentle. Hills in Tuensang, are steeper towards the east. The largest river of the State of Doiang flows into the Brahmaputra river. The other important rivers are Dikho, Jhanzi and Disai. There is a narrow strip of relatively flat land of about 400 km length running along the western boundary of the State with substantial potentialities for agriculture.

14.4 Soils of Nagaland have developed from sandstone, shale, and carbonaceous shales. The hilly soils are generally medium to shallow in depth, acidic, rich in organic carbon but very poor in phosphorous and potash. The soils in the river valleys and foothills are generally deep and not subjected to severe soil erosion as in the case of hill soils. These soils also are acidic, rich in organic matter but poor in phosphorous and potash.

14.5 The climate is generally bracing and healthy; the temperature

in summer ranging from 15°C to 37°C. The annual rainfall occurring mostly between April and October averages between 177 cm. and 254 cm. Precipitation in eastern parts is heavier.

14.6 Agriculture is mainly under 'Jhums' (shifting cultivation), although some of the tribes like Angamis and Chakhesangs who live predominantly in Kohima district have taken to permanent cultivation. The hill slopes have been terraced and grow rice. However the area under permanent cultivation constitutes hardly 25 per cent of total area cultivated in any year. 'Jhuming' as practised in Nagaland differs from Jhum cultivation elsewhere in two ways. Firstly, in Nagaland, Jhuming follows a cycle i.e. each plot is cultivated once or twice and then abandoned for a number of years before it is recultivated, the average period of the cycle being about 8 years. Secondly, in many cases, farmers exhibit awareness of the need for soil conservation. Methods as, laying three trunks laterally to the slope of the hill allowing tree-stumps to remain in Jhums and in a few cases, building bunds and digging channels are in vogue. However these efforts are sporadic and not practised widely. The resultant effect of shifting cultivation is extensive soil erosion on hill slopes.

14.7 The following table shows broad pattern of land use in Nagaland:

Table 14.1

Pattern of Land Use in Nagaland*

Details	Thousand hectares
1	2
Land set apart for cultivation	690.5
Reserved forests	32.9
Protected forests	51.8
Civil use	38.8
Area including forests belonging to villages, waste land etc.	834.8
Total	1648.8

**Source:* Techno Economic Survey (1968) NCAER.

During 1969-70, about 101,200 hectares were cultivated of which about 25,700 hectares of land was under permanent cultivation and nearly 75,500 hectares was under shifting cultivation. The State Government in its efforts to persuade people taking to permanent cultivation, has

embarked on various measures like subsidising terracing, supply of technical guidance and machinery for the purpose. The cost of terracing on the hill slopes is high and works out to Rs. 2,500/- to 3,500/- per hectare.

14.8 Rice is the staple crop in most of Nagaland except some parts in the east. During 1969-70, it was grown over 60 per cent of total area cultivated. Other crops grown are maize, pulses, vegetables and fruits, varying from place to place. By and large in the western flank and south, pulses, potatoes and chillies are more important, whereas maize is important in central parts and oranges and pineapples in the eastern region. Vegetables are grown all over Nagaland in the kitchen gardens for family consumption. The following table gives the areaswise distribution of different crops during 1969-70:

Table 14.2

Distribution of Different Crops—1969-70

Crop	Area (hectares)	Percentage to total cultivated area
1	2	3
Rice	60,200	59.8
Maize	9,200	9.1
Other cereals and millets	20,600	20.3
Spices	1,150	1.1
Pulses	3,250	3.1
Oil seeds	1,912	1.9
Sugarcane	1,350	1.3
Fibres	210	0.2
Potato & sweet potato	3,290	3.2
Total	101,162	100.0

14.9 There are three types of irrigation in Nagaland:

(a) Contour channels from hill streams at higher altitudes.
(b) Contour channels leading from small reservoirs on small dams over streams.
(c) Lift irrigation from rivers.

14.10 Of the above, the first is by far the most common method prevalent in Nagaland, which has been in vogue for a long time amongst

the Angamis and Chakhesang tribes. Contour channels were dug for diverting the hill streams into the terraced lands in Kohima district. It is reported that practically all the terraced area receives irrigation from the contour canals. Before Independence, this was done mostly by the farmers' individual and co-operative efforts. Since the First Five Year Plan, the area under irrigation through diversion channels, has been extended through Governmental aid. Construction of the diversion channels and the terracing of land is being subsidised by the Government to the extent ranging from 50 to 100 per cent. The schemes are implemented by the Department of Agriculture by grant of cash subsidy and supply of construction materials like cement, pipes etc. Technieal guidance wherever necessary is also provided.

14.11 Irrigation from small reservoir has not been practised in Nagaland in any big way. Earlier Kucha bunds were constructed across streams during the post-monsoon period for diverting small quantities of available flows. However these bunds were of a temporary nature and used to get washed away by floods. There are a number of streams and rivers in Nagaland with considerable water potential. Investigations are needed for assessing the potentialities and harnessing of the water resources. A scheme on Kupanala has been investigated.

14.12 The State also has worked out some proposals for utilising the tail water of the proposed 80,000 KW Doyang Hydro Electric Project to irrigate about 60,000 hectares of land.

14.13 Lift irrigation from streams is also gaining in popularity in the State. To encourage the farmers to take to lift irrigation the State Government supplies pumps at 50 per cent subsidy. The State Government has proposals during the Fourth Plan to instal 170 pumping sets and to dig 20 open dugwells in the foothill areas. There are proposals to grant 50 per cent subsidy to cultivators for extension of Electric lines for irrigation purposes.

14.14 There is a long strip of 400 km. and about 80 sq.km. land adjoining the Sibsagar and Nowgong districts of Assam which can be provided with irrigation facilities from the rivers and streams flowing in the area. The Commission recommends that the Union Government should assist the State Government to carry out a detailed investigation of its irrigation potential including the feasibility of constructing tubewells in some valleys.

CHAPTER XV

ORISSA

The State of Orissa took its presents hape in 1949 when 24 Princely States of Eastern India merged with the then Orissa State comprising six districts. As constituted today, it has 13 districts spread over an area of 155,842 sq.km. Orissa shares a common boundary with West Bengal in the North East, Bihar in the North, Madhya Pradesh in the West and Andhra Pradesh in the South. The State has an eastern coast line of 402 km. along the Bay of Bengal.

The population of Orissa, according to the 1971 census was 21.94 millions, living in 80 towns and 52,125 villages. The population density is 141 per sq. km. against the all-India average of 182. The geographical area of the State forms nearly 4.8 per cent of the total area of the country, while its population constitutes nearly 4 per cent of the total population. A special feature of the population in Orissa is that nearly 40 per cent of it consists of scheduled castes and scheduled tribes.

For purposes of economic analysis, the State has been traditionally divided into two regions, viz., the Coastal region consisting of the more developed areas of Balasore, Cuttack, Ganjam and Puri districts, and the inland region comprising the remaining nine districts. Some of the inland districts, like Sambalpur, Sundergarh have, of late, advanced to the level of the Coastal districts, thanks to major irrigation projects located within their boundaries.

Orissa's long coast line and its numerous rivers, and natural and man-made lakes make it one of the important fishing areas of the country. The State exports large quantities of sea-fish caught in the extensive Chilka lake and also fresh water fish, to cities like Calcutta.

The bulk of the population—nearly 91.7 per cent lives in villages, against the all-India figure of 80.1 per cent.

The major rivers in the State are the Mahanadi, the Brahmani, the Baitarani, the Burhabalang, the Rushikulya, the Subarnarekha and the Salandi. Prior to 1951, the two important irrigation systems were the Orissa Canal System (Mahanadi, Birupa, Brahmani and Baitarani) and the Rushikulya Canal System. After Independence, the Hirakud dam and the Mundali Weir across the Mahanadi, and the Salandi dam across the Salandi river, were the important projects undertaken.

Physical Features

15.2 Orissa is a maritime State with an extensive plateau sloping gently into the Coastal plain. The Mahanadi, flowing from west to east, cuts the plateau into two well-defined parts. The area north of the river, is an extension of the Chhotanagpur plateau and the area south of it, is covered by the Eastern Ghats and its numerous spurs. Towards the west and south-west of the State, there are four well-defined physical regions, the northern plateau, the Eastern Ghats, the coastal plain, and the erosional plains of the Central table land.

The Northern Plateau

The Brahmani and the Baitarani, flowing through the northern plateau, dissect it into three blocks. The eastern block consists of the heavily forested hills of the Mayurbhanj district and the peneplain which slopes from these hills to the Bay of Bengal. The middle block is also a well-forested hill region, which occupies most of Keonjhar district, and parts of Dhenkanal and Sundergarh districts. The western block of the plateau is flat-topped and steep-edged, with dense forests, in parts. Most of the region receives 1,626 mm. to 1,830 mm. of rainfall. The northern plateau is richly endowed with minerals. The Dharwar rocks of Mayurbhanj, Keonjhar and Sundergarh are sources of iron ore and manganese deposits, and the Gondwana rocks of Talcher have large deposits of coal. Other minerals which occur in this plateau are lime stone, chromite and dolomite.

Eastern Ghats

The Eastern Ghats rise abruptly and steeply on the east, and slope gently to a dissected plateau in the west. This plateau contains some highly fertile open valleys. The annual rainfall in most of this region is between 1,270 mm. and 1,524 mm. The rocks of the Eastern Ghats have so far proved to be of little economic value, although some manganese and graphite deposits have been found. The principal wealth of this region is its forests.

The Mahanadi-Tel basin covering two-thirds of Sambalpur and Bolangir districts, and one-third of Kalahandi district is the more important of the two erosional plains of Orissa. The other is in Koraput district, lying in the south west of the State. In addition, there are three important valleys, viz., those of the Baitarani, Brahmani and Mahanadi, all located in the Central and Western parts of the northern plateau. The erosional plains and river valleys constitute the more fertile tracts in the interior of the State.

Coastal Plains

The Coastal plains stretching over districts of Balasore, Cuttack, Puri and a part of Ganjam are fertile and well suited for intensive cultivation. The heart of the region is the large delta formed by the Mahanadi, Brahmani and Baitarani. The plains which are most densely populated also account for most of the agricultural output.

Situated partly in Puri district and partly in Ganjam, the Chilka lake is the most important of the several estuaries in Orissa. It is a pear-shaped lagoon about 64 km. long and with an average width of 19 km. in the north, and about 8 km. in the south, with about 114 villages around it or on islands in it, most being inhabited by fishermen. The lake, which is fed both by fresh and saline water, is very rich in fish. The catch per hectare of water compares favourably with those in similar lakes in other parts of the world.

Soils, Climate and Rainfall

15.3 The Coastal plain measuring about 23,300 sq. km. comprises the delta formed by the estuaries of the Mahanadi, Brahmani and Baitarani rivers. The alluvial soils of this region are, agriculturally, the most important. The nature of the alluvium varies from district to district; the soils of Cuttack being clay and clayey loams, as compared to the sands and sandy loams found in Balasore, Puri and Ganjam. The soil in general is deficient in phosphoric acid and has a low nitrogen content, but sufficient of potash.

The Central table land includes a number of erosional plains and river basins in districts of Bolangir, Sambalpur and Dhenkanal. The Mahanadi-Tel basin, and other river valleys, have a red soil that is poor in nitrogen, phosphoric acid, humus and lime, but which produces good crops where these soils are not shallow. Black soil is found scattered in Dhenkanal, Phulbani, Kalahandi and Bolangir districts. It is rich in potassium and magnesium and poor in nitrogen and phosphorus.

The northern plateau covers districts of Mayurbhanj, Keonjhar, Sundargarh and Palehara sub-division of Dhenkanal. Much of the plateau is hilly, heavily forested and unsuitable for agriculture. Two-thirds of the northern plateau is covered by a red soil similar to that found in the Central table land.

The Eastern Ghats region covers districts of Koraput, Kalahandi and part of Ganjam. This region has laterite soils. As a rule, these soils are poor in plant materials, chiefly phosphate and potash, though they are fairly rich in nitrogen.

Considering the general distribution of soils and the topography of the State, it is clear that the major proportion of increase in agricultural production will have to come from the delta area of the coastal region, the

peneplains and river basins of the Central table land, and the up-land plain in Mayurbhanj and parts of Koraput. The remainder of Orissa, is physiographically less suitable for agricultural development.

15.4 The climate of Orissa is characterised by high temperatures and medium to high rainfall. The mean annual temperature is 33°C, rising to 38°C in April and May, falling to 35°C in July and to about 27°C in January. The mean annual rainfall of the State varies from 1,400 mm. to 1,600 mm. About 81 per cent of the precipitation is received during June to September, mainly from the South West monsoon. Though the variability of rainfall is relatively high, the fairly high annual precipitation causes floods. The climatic conditions are almost ideal for growing such crops as rice, sugarcane and jute.

15.5 The northern plateau consisting of Mayurbhanj, Keonjhar, Sundergarh and Kuchinda and Deogarh sub-Divisions of Sambalpur district get about 1,700 mm. of rainfall. The Eastern Ghat region consisting of Kalahandi, Koraput, Phulbani and the hilly parts of Ganjam district get about 1,350 mm. The coastal plains, consisting of Balasore, Cuttack,

Table 15.1

Land Use Pattern—Orissa

Classification	Area (Thousand hectares)	Percentage of Reporting area
1	2	3
Geographical area	15,584	
Reporting area	15,540	100.0
Area under forests	3,591	23.1
Not available for cultivation	2,542	16.4
Other uncultivated land excluding fallow land	2,567	16.5
Fallow land	851	5.5
Net area sown	5,989	38.5
Total cropped area	7,446	—
Area sown more than once	1,457	—
Net irrigated area	1,313	—
Gross irrigated area	1,778	—
Percentage of net irrigated area to net cultivated area	—	21.9
Percentage of gross irrigated area to gross cultivated area	—	23.9

Source: Directorate of Economics & Statistics, Ministry of Agriculture.

Puri districts and a part of Ganjam district, receive 1,420 mm. and the Central table land consisting of Dhenkanal, Sambalpur and Bolangir districts get about 1,350 mm.

Land Use and Cropping Pattern

15.6 Table 15.1 shows the land utilisation statistics of the State during 1964-65, the latest year for which data are available.

15.7 During 1964-65, out of a gross cultivated area of 7.45 million hectares, 5.36 million hectares (73 per cent) was under food-grains. Table 15.2 shows the areas under different crops during that year.

Table 15.2

Principal Crops Grown in Orissa

Crop	Area (Thousand hectares)	Percentage to total cropped area
1	2	3
Rice	4,337	58.2
Maize	66	0.9
Wheat	15	0.2
Other millets	294	4.0
Total cereals and millets	4,712	63.3
Gram	20	0.3
Other pulses	712	9.5
Total pulses	732	9.8
Total food-grains	5,444	73.1
Total fruits	87	1.2
Total vegetables	312	4.2
Groundnut	66	0.9
Other oil seeds	276	3.7
Total oil seeds	342	4.6
Jute	53	0.7
Other crops	1,208	16.2
Total cropped area	7,446	100.0

Source: Directorate of Economics & Statistics, Ministry of Agriculture.

The above table shows that 78.5 per cent of the total cropped area (1964-65) was under food crops. Among foodgrains, rice accounted for 58.2 per cent, wheat and millets for 5.1 per cent and pulses for 9.8 per cent of the total cropped area. Among the non-food crops, oil seeds account for 4.6 per cent while other crops account for 16.9 per cent.

Agricultural production in Orissa is being encouraged by extending the benefits of irrigation, providing more improved seeds, fertilizers and

manures and by the adoption of scientific methods and improved implements. Provision of infrastructure services, credit and marketing, soil conservation, dry farming and reclamation are all part of the programme. The Intensive Agriculture District Programme (IADP) was introduced in the irrigated areas of the Sambalpur district. All these measures lead to increase in the production of important crops and by the end of the Third Plan the total yields for the State rose to:

Food grains	3.74 million tonnes
Oil seeds	0.11 million tonnes
Sugarcane (gur)	0.23 million tonnes
Jute	0.21 million bales of 180 kg. each.

Surface Water Resources

15.8 The following table shows the salient features of the principal rivers in Orissa.

Table 15.3

Annual Yields of Rivers of Orissa

River	Drainage area within Orissa (sq.km.)	Average annual run-off (m.cu.m.)	Remarks
1	2	3	4
Mahanadi and its tributaries	57,180	92,820	Yield for the entire basin
Burhabalang	4,500	2,578	
Baitarani	10,240	7,228	Small portion of catchment in Bihar
Brahmani	18,750	25,286	Yield for entire basin
Subarnarekha	3,200	10,435	,,
Salandi	666	567	
Rushikulya	7,956	1,764	
Vamsadhara	11,377 (total catchment)	3,663	Yield for entire basin
Nagavali	9,275 (total catchment)	2,430	
Godavari Basin			
Kolab, Sileru, Indravati	17,752	18,983	
Bahuda	978 (total catchment)	222	Yield for entire catchment
Salia	246	111	

Source: State Replies to Irrigation Commission.
Note: The yields of basins are estimated from Strange's table.

All these rivers are rainfed and the bulk of their run off is during the monsoon period. More than 80 per cent of the flow occurs during the months of June to October, except in the Indravati, Kolab, Vamsadhara and Rushikulya rivers, where the flow continues to be substantial even up to December due to the north-east monsoon. Table 15.4 shows the percentage of yields on some rivers in different parts of the year.

Table 15.4

Seasonal Flows of Rivers of Orissa

River	Percentage of yield			Years for which average has been worked out
	June-Sept.	Oct-Dec.	Jan-May	
1	2	3	4	5
Mahanadi at Naraj	82	14	4	1926-1950
Baitarani at Baitarani anicut	83	13	4	1964-69
Brahmani-Akhuapada anicut	82	14	4	1964-1969
Subaranarekha at Rajghat	86	12	2	1964-1969
Burhabalang at Kuliana dam site	79	18	3	1964
Indravati	79	17	4	1959-1967
Upper Kolab	66	21	13	1962-1965
Vamsadhara	58	38	4	1951-1958
Rushikulya	82	18	—	

Source: State's replies to the Commission.

Hydrological Observations

15.9 In Orissa, the responsibility for making hydrological observations on the major rivers, vests in the Irrigation Department. River gauging is normally done at functioning projects or on projects under investigation, and it is done by the officers dealing with the project. Discharge observations for the Mahanadi have been recorded at Naraj from 1921 onwards. For the Brahmani and Baitarani, discharge observations have been conducted since 1964 and for the Subarnarekha since 1966 at Rajghat.

Ground Water Resources

15.10 The Geological Survey of India have carried out investigations for ground water in Coastal Orissa. Explorations in the alluvial plains

of the Balasore and Cuttack districts over an area of 4,000 sq. km. have revealed that the ground water aquifers have generally a south-easterly slope. In the Bhadrak-Bandarpokhari area, good granular zones were encountered, mostly within a depth of 130 m. In the south-eastern area, fresh water-bearing formations occur between 135 to 225 m. and the shallower zones are saline. The Bastar-Balasore, Agarpara-Nalqunda, Panikolli-Palasa areas can be developed for large scale ground water supplies. In this area the tube wells are generally yielding 89,000 to 180,000 litres of water per hour. The ground water in the Chandipur and Soron areas can be developed on a moderate scale, where tube wells may yield from 19,000 to 30,000 litres per hour. In the saline tract, fresh water occurs in granular zones between depths of 180 m. and 270 m.

Systematic ground water studies have been made in Balasore and Cuttack districts. The near-surface aquifers there generally have fresh water, with less than 250 ppm of chlorides, which is fit for irrigation, except in the pre-Cambrian formations where the chloride content goes up to 450 ppm. In the Coastal tracts, the aquifer zones within 152 m. of the surface are saline, with the chloride content ranging from 750 to more than 7,000 ppm. At lower depths, a better quality of ground water is found with a chloride content of 100 ppm.

Present Stage of Development of Irrigation

15.11 Prior to 1951, the total area irrigated from all sources was 0.76 million hectares (0.15 million from major and medium schemes and 0.61 million from minor). Important projects in operation in 1951 were, the Orissa Canal System in Balasore and Cuttack districts (100 thousand hectares), the Rushikalaya Canal System (45 thousand hectares) and the Mahendratanaya System (4,050 hectares) in Ganjam district and the Beldia project (3,240 hectares) in Mayurbhanj district.

The State Government has undertaken a number of major and medium irrigation projects, the biggest of them being the Hirakud Project across the Mahanadi. Other important projects are the Mahanadi Delta Scheme and the Salandi Scheme. By these major projects and minor schemes, the net irrigated area had increased to 1.31 million hectares by the end of 1964-65.

15.12 Some of the more important projects are briefly described in the following paragraphs.

Hirakud Project

The Hirakud is by far the most important project taken up in Orissa

after Independence. A dam has been constructed near Sambalpur across the Mahanadi, which rises near Sihowa in the Raipur district of Madhya Pradesh and after draining an area of 69,410 sq. km. in that, enters Orissa. In Orissa it drains an area of 78,480 sq. km. and finally falls into the Bay of Bengal. Important tributaries of the Mahanadi are—the Seonath, the Jonk, the Hasdeo, the Mand, the Ib, the Ong and the Tel. The Mahanadi delta begins at Naraj and the Hirakud dam is built about 322 km. up-stream of Naraj.

The Hirakud project is multipurpose. It consists of a dam across the Mahanadi, below its confluence with the Ib river, about 10 km. from Sambalpur. The dam consists of a 1,148 m. long masonry and concrete section and a 3,652 m. long earthen section. There are dykes on both sides, totalling a length of 20,656 m. The maximum height of the masonry dam is 61 m. and in the earthen portion 59 m. The reservoir has a gross storage capacity of 8,141 m.cu.m. of which 5,822 m.cu.m. is the live storage. The project generates 270 MW of power (installed capacity) and irrigates 0.24 million hectares of land. In addition, it provides substantial relief from floods to the delta area. Work on the project started during 1947-48; the dam completed in 1957, and irrigation started thereafter. The full irrigation potential is expected to be developed by the end of the Fourth Plan though the power potential had been fully utilised by 1963-64.

Mahanadi Delta Irrigation Scheme

The Mahanadi Delta Scheme has been taken up to utilise 226-283 cumecs of water released from the Hirakud hydro-power station. It is proposed to utilise this water to irrigate the land between the Kathjuri and Daya rivers and to stabilise irrigation under the Orissa Canal System.

The project consists of a weir across the Mahanadi near Mundali village in Cuttack district, slightly upstream of Naraj. The weir is 1,363 m. long and the new canal taking off from it will carry a discharge of 170 cumecs to irrigate new areas, and to stabilise irrigation in the old command. The new area to be brought under irrigation is 0.21 million hectares, while the extension of the irrigated area in the command of the old canals will be 0.20 million hectares. The net area expected to be irrigated on completion of this project is 0.41 million hectares including 79 thousand hectares under the Orissa Canals. The gross area proposed to be irrigated from the Mahanadi Delta Scheme is 0.68 million hectares. Work on the project began in 1955-56. Irrigation started from 1967 and the distribution system is expected to be completed during the Fourth Plan period.

Salandi Project

The project envisages a composite dam near Hadgarh (Keonjhar district)

and a barrage at Bidyadharpur across the river Salandi. The dam is 817 m. long of which 177 m. is masonry, and the rest is earth with a maximum height of 52 m. An area of 62 thousand hectares is expected to get irrigation facilities on completion of this project. The work on the project started in 1961 and is expected to be completed during the Fourth Plan.

The State has also undertaken a number of medium projects. Appendix 15.1 shows the salient features of projects (irrigating 4,050 hectares and above) undertaken in the State.

Minor Irrigation

15.13 Prior to 1951, a total area of 0.61 million hectares was irrigated through minor schemes, of which 0.56 million hectares was from surface and 0.05 million hectares from ground water resources. This figure rose to 0.97 million hectares, that is 0.90 million hectares from surface and 0.07 million hectares from ground water in 1964-65.

In Orissa, dug wells are not usually used for irrigation. They are generally used for drinking water. However, kuchha wells 1.5 to 3 m. deep, are dug along river banks for growing vegetables. The area commanded by these wells is small. In 1965-66 there were 5,383 tanks in the State and the area under irrigation from these tanks was only 115,114 hectares which works out to an average of 21 hectares per tank. By 1968-69, an additional area of 17,397 hectares was brought under irrigation by tanks. Tanks irrigating less than 25 hectares are maintained by the Panchayat Samitis, and those irrigating more than 25 hectares form another category, maintained by the Rural Engineering Organisation.

The construction of tube wells has been taken up in the State only recently, and at the end of March 1969, there were only 202 tube wells irrigating 3,083 hectares, that is an average of 15 hectares per tube well. A separate Directorate under the Irrigation and Power Department is responsible for the construction, management and operation of the tube-wells and the distribution of their water. The ayacuts under State tube-wells are not fully developed and up to 1969, against the commanded area of 11,153 hectares, the area irrigated was only 3,083 hectares. Tube wells run for a maximum period of 1,500 hours in a year and their water is usually used in the rabi season. Obviously these working hours are inadequate, and there is need to examine how full utilisation of their potential can be achieved.

15.14 The net area irrigated from all sources at the end of 1964-65 stood at 1.31 million hectares. It was as follows:

Source	Area irrigated (*Thousand hectares*)
Canals	634
Tanks	245
Wells	26
Other sources	408
Total	1,313

No overall assessment of the surface water resources within the State has been made so far. However, on a rough estimate about 166,000 m.cu.m. of water are carried by its rivers annually and that prior to 1951, 1850 m.cu.m. of water was utilised for irrigation. An additional 11,607 m.cu.m. of water will be utilised by schemes at present under construction.

Ayacut Development

15.15 In Chapter VII of Volume I of our Report, we have discussed the problems of ayacut development and have made recommendations for their speedy development. In Orissa, the difficulties faced by the farmers and project authorities in this regard are the same as in other ayacuts. We would draw the attention of the State Government to our recommendations, and particularly to those which relate to the State's role in extension work and the need to supply funds to farmers for the purpose of development.

We have also dealt there with the problems of land-levelling and land-shaping, and the recommendations in this regard are of special relevance to certain areas in the Hirakud Project.

Initially in the Hirakud Project, commands of outlets were fixed at 120 to 200 hectares. Obviously these commands were too big for the farmers to manage internal distribution. The excess water, during the early stages, used to be let out during the storm periods which flowed from field to field until it reached drainage channels. Later the Government reduced the commands under outlets to a maximum of 40 hectare limit, which improved the situation. In Volume I we have also dealt with the problem of field channels and we would like our recommendations to be studied carefully for their application to ayacuts in Orissa.

Where the area served is backward we would like the State to pay special attention to the development of infra-structure, roads, postal communication facilities etc. and the improvement of marketing services such as setting up of mandis, providing warehousing and storage, banking

facilities etc. It would be necessary to announce the support price for food grains before the sowing season to provide the farmers with an assured market. Areas where sugarcane is allowed to be grown should be provided sugar mills.

The State will have to play an active role in evolving new varieties of seed and multiple cropping to suit local conditions. We are glad that there is increasing awareness on the part of the State Government about importance and urgency of ayacut development.

Drought Affected Areas

15.16 The State Government is of opinion that there are large areas which are prone to drought because of the variation and uneven distribution of rainfall. According to its assessment, out of 314 community development blocks, 67 suffer from drought. These blocks are situated mostly in the erosional and coastal plains, where paddy is the most important crop. In Chapter VIII of Volume I of our Report, we have discussed in detail the criteria for declaring any area to be drought affected. On the basis of these criteria the blocks mentioned above do not qualify for inclusion in the list of drought affected areas, the annual rainfall in these areas being about 140 cm. with a variation of about 20 per cent. We consider that there is sufficient scope for growing kharif crops and find ourselves unable to agree with the assessment of the State Government. We have noted that since the creation of Orissa State in 1936, famine has not been declared once in any part of the State, although in countrywide drought years of 1965 and 1966 some areas in the Kalahandi and Bolangir districts were declared as scarcity affected areas.

We find that the blocks listed by the State Government do not have any major or medium projects in operation or under construction. Even the minor projects are limited in numbers and extent of area irrigated. Barely 46,000 hectares out of the total area of 3.7 million hectares in these blocks, that is 1.3 per cent of the area, has the benefits of irrigation. The State Government has estimated that the untapped water potential in the districts, having drought affected areas, is nearly 5,427 m.cu.m. on 50 per cent dependability. There is a proposal to implement 133 minor schemes, which is likely to benefit 285,000 hectares of land. We would urge that high priority should be allocated to these minor irrigation works. We are also of opinion that possibilities of developing conjunctive use of surface and ground water be explored.

Future Possibilities of Irrigation

15.17 In May 1945, Dr. A. N. Khosla, then Chairman, Central Water-

ways, Irrigation & Navigation Commission, conceived a plan for the unified development of the Mahanadi Basin as a first step in the integrated development of the river basins of Orissa. This plan envisaged the construction of three storage dams on the Mahanadi, at Hirakud, Tikerpara and Naraj to control floods on the Mahanadi and to develop power, irrigation, navigation, pisciculture and other facilities.

The construction of the Hirakud Dam and power plant was undertaken in 1949-50 immediately after the project report had been approved and was the first stage in the plan for the basin-wide development of the Mahanadi river. The dam was completed in 1956 and inaugurated in 1957. The plan to build a dam at Naraj was dropped and a decision was taken to construct a diversion weir at Mundali. Work on this is in progress.

A fresh Master Plan, which was an extension of the earlier Master Plan was prepared in May, 1963 envisaging the integrated development of all river basins in Orissa for irrigation, power, flood control and navigation. Its essentials are shown below.

Table 15.5*

Projects included in Master Plan of Orissa

Project	Area to be irrigated (Thousand hectares)	Power generation at 30% LF (MW)
1	2	3
I. *Project completed/Under construction*		
Hirakud (Mahanadi)	243	427.00
Mahanadi Delta („)	680	—
Machkund (Godavari)	—	42.20
Balimela („)	155	480.00
Total:	1,078	949.20
Irrigation Development up to 1968-69	541	
To be developed	537	
II. *Proposed Projects*		
Mahanadi Basin		
Tikerpara	—	2,750
Gania	1,750 +324 in Andhra & West Bengal	1,529

Table 15.5* — Contd.

Project	Area to be irrigated (Thousand hectares)	Power generation at 30% LF (MW)
1	2	3
Brahmani Basin		
Tikra-Barakot	57	6
Barakot	361	1,053
Degoan—Rampur	—	120
Baitarani Basin		
Bhimkund	25	624
Godavari Basin		
Indravati	226	780
Upper Kolab	130	264
Lower Kolab	65	367.5
Total:	2,614 +324 in A.P. & W. Bengal	7,493.5

**Source:* Orissa's Decade of Destiny.

The Master Plan also includes a number of medium irrigation and power projects on several tributaries of the main rivers.

Irrigation to the extent of 0.54 million hectares had been developed (in 1968-69) under the Hirakud and Mahanadi Delta Projects. When all the remaining schemes in various river basins, as enumerated above, have been implemented, an additional area of 3.15 million hectares will be brought under irrigation of which 0.54 million hectares will be from projects already under construction and 2.61 million hectares from projects proposed to be taken up. These projects will, in addition, generate 7.5 million KW of power at a 30 per cent load factor. The total cost will be Rs. 9,860 million.*

15.18 The State proposes to take up two major irrigation schemes, namely the Upper Indravati (Kalahandi district) and the Anandpur Barrage (Keonjhar, Balasore and Cuttack districts) during the Fourth Plan. In addition, it proposes to take up eight medium irrigation projects. The additional irrigation from these new major and medium projects will be 0.29 million hectares. We have been informed that all the continuing

*At the 1963 price levels.

major and medium irrigation projects carried over from the First, Second and Third Plans will be completed during the Fouth Plan period.

Table 15.6

Projects Proposed during Fourth Plan—Salient Features

Project	District
1	2
I. *MAJOR PROJECTS*	
Upper Indravati	Kalahandi
Anandpur Barrage	Keonjhar
II. *MEDIUM PROJECTS*	
Uttai	Kalahandi
Ong	Bolangir
Bagh	Phulbani
Salchua Tangna	Mayurbhanj
Dadarghati	Dhenkanal
Mahanadi—Chitrotpala Mahanadi paika	Cuttack
Bagna	Ganjam
Dahnka	Puri

Source: Draft Fourth Five Year Plan (1969-74) Orissa pages 75 and 77.

Floods, Waterlogging and Drainage

15.19 The Mahanadi, Brahmani and Baitarani rivers when in flood, create a single flood zone, endangering nearly 2,450 sq. km. in the Coastal regions. The Burhabalang and the Subarnarekha also cause damage to areas in their deltas measuring 440 sq. km.

The main effects of these floods are:

(a) prolonged submersion of vast agricultural lands in the middle and lower deltas, as nearly half of the flood water overflows the banks;

(b) fertile land is rendered permanently unfit for cultivation because of the deposit of sand;

(c) the washing away of villages and land through heavy scouring of river banks;

(d) scouring of river banks occuring down-stream of the Hirakud reservoir, due to the release of large volume of silt free water from the dam;

(e) formation of sand-bars across the mouths of the rivers from south-west to north-east due to littoral drift.

Of all the projects in Orissa, the Hirakud dam has the greatest flood-control potential. A great deal of flood control work done since 1954 consisted of raising and strengthening old embankments and providing bank-protection works. During the first three Plans, 295 schemes were approved for Central loan assistance involving:

(a) construction of new embankments
(b) raising and strengthening existing embankments;
(c) town protection;
(d) raising villages above flood level;
(e) making cuts for the quick drainage of flood water; and
(f) other miscellaneous flood control works.

From the statistics of flood damage it appears that the flood affected area in the State had varied from 28 thousand hectares in 1958 to 1.4 million hectares in 1960, an average of 0.49 million hectares. The flood control works completed so far give protection to a total area of 0.54 million hectares.

The Orissa State Government appointed a Flood Enquiry Committee which submitted its final report in 1962. The Committee recommended specific schemes in various river basins. Their more important proposals were the construction of new embankments, the raising and strengthening of existing embankments, and providing cuts and escapes.

We are of opinion that in order to achieve effective flood control, at least one flood retention reservoir should be built on each of the rivers—Mahanadi, Brahmani and Baitarani. We would draw the attention of the State Government to our recommendations on the subject of flood forecasting and flood warning, in Chapter XIII of Volume I of our Report.

15.20 Waterlogging is mainly confined to the delta, where in the course of its formation, the river beds have gradually risen higher than the adjoining land. The rivers in flood lead to the formation of small lagoons and swamps in the doabs towards the sea-coast.

Waterlogging due to flow irrigation in the major projects is negligible. In the Hirakud project, after more than ten years of flow irrigation, no waterlogging problem has arisen. Even where low-lying lands become marshy due to seepage from higher fields, two successful paddy crops a year can be grown.

Water Rates

15.21 Water rates in the State are levied under the 'Orissa Irrigation Act of 1959'. The Act came into force in different parts of the State in

different years. It first came into force on the first of June 1961 in all areas, except areas governed by the Bengal Irrigation Act, 1876 and the Madras Irrigation Cess Act. On the first June 1963, the Act extended to areas covered by the Bengal Irrigation Act, 1876, and on the first July 1963 in areas covered by the Madras Irrigation Cess Act, 1865. The Act was amended by Act 24 of 1962.

The Orissa Irrigation Act provides for three kinds of rates:

(i) the basic water rate which is compulsory for all lands in the ayacut growing the staple cereal crop, viz. paddy;
(ii) the water cess which is to be charged in lieu of the basic water rate; and
(iii) an optional water rate which is levied for each kind of crop on a voluntary basis, on those who choose to take water.

The Act provides for the classification of irrigation works belonging to or constructed by or on behalf of the State Government. Further, it makes provision for the compulsory basic water rate to be levied at different rates for meeting peculiar conditions or circumstances under which water is provided.

The Schedule for the levy of a compulsory basic water rate, and water rates for different classes of irrigation works is as follows:

Class of irrigation works	*Rate per acre per year*
1st Class	Rs. 4.00
2nd Class	Rs. 3.00
3rd Class	Rs. 2.00
4th Class	Re. 1.00

(Notification No. 13479/III-W-8/68R, dated 23.3.1968).

In respect of new irrigation works, or irrigation works where the compulsory basic water rate will be levied for the first time, the following principles are adopted:

(a)	In the first year when water is let out in the ayacut. ..	Nil
(b)	In the second year when water is let out in the ayacut. ..	50 per cent of the appropriate rate.
(c)	In the third year when -do- ..	75 per cent of the appropriate rate.
(d)	In the fourth year and thereafter. ..	100 per cent of the appropriate rate.

In respect of the old irrigation works where water rates had already been in force, the following principles are adopted:

(a) First year of enforcement of the provisions of the Orissa Irrigation Act, 1959. ..	50 per cent of the appropriate rate, or the rate already in force, whichever is higher.
(b) Second year of enforcement of the Act. ..	75 per cent ,, ,,
(c) Third year of enforcement of the Act, and thereafter. ..	100 per cent of the appropriate rate.

Water Rates for Crops other than Staple Cereal Crop*

Crop	Rate per acre per year	
	Flow irrigation	Lift irrigation and tubewell**
1	2	3
Paddy (Kharif)	shown separately	Rs. 16.80
Dalua	Rs. 8.00	Rs. 70.00
Tobacco	Rs. 15.00	Rs. 33.60
Potato	Rs. 10.00	Rs. 33.60
Vegetables including peas	Rs. 8.00	Rs. 42.00
Onion	Rs. 10.00	Rs. 28.00
Wheat	Rs. 2.00	Rs. 21.00
Maize	Rs. 5.00	Rs. 33.60
	(hybrid variety)	
Mung	Re. 1.00	Rs. 5.60
Groundnut	Rs. 5.00	Rs. 21.00
Orchards	Rs. 12.00	Rs. 42.00
Sugarcane	Rs. 14.00	Rs. 63.00
Jute	Rs. 3.00	Rs. 14.00
Fodder	Rs. 5.00	Rs. 28.00
Pulses	Rs. 2.00	Rs. 7.00
Cotton	Rs. 10.00	Rs. 28.00
Til (Oilseeds)	Rs. 2.00	Rs. 11.20
Betel leaf	Rs. 30.00	Rs. 112.00
Arhar	Rs. 5.00	Rs. 21.00
Sun-hemp	Rs. 7.00	Rs, 14.00
Chilly	Rs. 5.00	Rs. 33.60
Saru	Rs. 30.00	Rs. 126.00
Ragi	Rs. 2.50	Rs. 8.40
Mustard	Re. 1.00	Rs. 4.20

*Amended vide Notification No. 13479-III-W-8/68-R, dated 12.3.68.

**Rates for lift irrigation given effect to from 1.6.69. The rates take into account the quantum of water required for crops, the duration of supply and the operation and maintenance cost.

Water is supplied to farmers on an application being made. In case of crops other than staple crops, i.e., paddy kharif, applications have been made yearly. The water rates are collected by irrigation officers of the Revenue Department.

In 1967, the Orissa Government appointed a Committee called "The Irrigation Rates Revision Committee" to:

(a) study the question of levy of the water rates;

(b) review the various types of water rates for crops leviable under the Orissa Irrigation Act, 1959 and the rules made thereunder; and

(c) recommend to Government, if there is a case for modification, alteration of exemption in levy of various types and quantum of water rates in different areas of the State.

The Committee have made recommendations to the State Government, which are under consideration.

Betterment Levy

15.22 The State Government has enacted legislation for the collection of betterment levy on lands to which irrigation is provided. The levy applies both to flow and to lift irrigation. It is charged on the irrigable area in the command. The levy to be recovered has been fixed at 'half the difference between the increase in the capital value and the estimated cost of making the lands fit for irrigation'. The increase in the capital value is deemed to be ten times of the annual increase in the gross produce from the land. According to the Act, the payment of betterment levy can be made either in a lump sum or in 16 instalments:

(i) the first two instalments are fixed at 1/30th of the levy;

(ii) the balance is payable in 14 instalments, each being 1/15th of the levy.

The charges are payable on the 15th April following the kharif season in which irrigation facilities are first provided. However, so far, no betterment charges have been collected in the State, and the Act remains a dead letter.

Tours, Observations and Impressions

15.23 The Commission toured Orissa in November 1971. Among the places visited by them the most important was the Hirakud Dam and its command area. On the way back the Commission stopped at Dhenkanal, where the farmers of the locality met them. At Bhubaneshwar they held discussions with the Chief Minister, Ministers for Irrigation and Rural Works and Officers of the State Government. The Commission paid a visit to the Delta and held at Puri discussions with a number of Chairmen of Panchayat Samitis. The Commission availed of the opportunity to visit the Central Rice Research Institute at Cuttack.

15.24 Rice is Orissa's main crop, in both kharif and rabi seasons. The abundance of rainfall and irrigation have combined to raise the development of the rice crop hundred per cent both in the Hirakud and the Mahanadi projects. In Hirakud ayacut against the projected irrigation of 0.24 million hectares—0.15 in kharif and 0.09 in rabi—the actual achievement in 1970-71 was 0.23 million hectares—0.15 in kharif and 0.08 in rabi.

The cropping pattern as originally envisaged in the Hirakud Project made allowance for medium and light irrigated crops in rabi season, but in practice only the high-yielding varieties of rice are grown. Little attempt seems to have been made to adhere to the original cropping pattern. We were told by the Chief Engineer of the State that the area under rabi rice could be increased, if its cultivation is limited to compact blocks. It would also increase if farmers were given incentive to dig shallow wells for irrigation. We have little doubt that if medium and light irrigated crops, as envisaged in the project report, were raised, it may be possible to attain a hundred per cent intensity in rabi. The Commission are of opinion that this matter deserves scrutiny at the hands of the State Government.

15.25 Under the Irrigation Laws of the State, if seventyfive per cent of the farmers of an area under an outlet apply for kharif irrigation that area is granted irrigation licence for a period from 2 to 5 years. For irrigation during the second crop season, applications have to be made every year. The Tehsildar has been designated the Irrigation Officer for the purpose of receiving applications. The assessment and collection of water rates are both made by the Revenue officials.

At Hirakud, a large number of farmers who met us, complained that applications for the supply of water from minor tanks, including those having a command of less than 24 hectares and are under the management of the Gram Panchayats have to be made to the Tehsildar. Considerable delays occur in the grant of applications, and the small farmers are the worst sufferers. We were informed by the State officers that the revision of the procedure has been under the consideration of the State Government since 1966-67. We are of opinion that matter calls for an immediate action and the Irrigation engineers should be given the power to sanction applications for irrigation. They should prepare bills for water rates; the collection of the bills remaining the responsibility of the Revenue Department as at present.

15.26 Some farmers complained that there is shortage of water at the tail-end of canals in the Hirakud Project due to the absence of shutters on many watercourses and unauthorised cutting of canal embankments in the upper reaches. Sometimes areas at the tail-end are flooded due to lack of drainage facilities. These complaints deserve to be looked into.

15.27 In the Chakuli Farm in the Hirakud ayacut some experiments have been made in water-management by constructing field channels and drainage channels in rice fields. It was found that the water-requirement of rice was thereby reduced to 97 cm including the effective rainfall. As against this in field to field irrigation the water requirements are 114 cm. We recommend that the economics of constructing field channels and drainage channels should be carefully examined and action taken.

15.28 One of the outstanding problems of the Hirakud Project is the soil conservation in the catchment area. The catchment area of the project extends over 83,000 sq. km of which only 14,000 falls with Orissa State. The remaining area, about five-sixths of the whole, is in Madhya Pradesh. Soil conservation works in Orissa first started in 1956-57 with one division. A second division was set up in 1971. However, so far less than one fifth, that is about 18,210 hectares, of the total critical area of 112,900 hectares has been tackled.

The Forest Department and Agriculture Departments are both doing the conservation work in their areas and though mutual consultations are held from time to time, a unified control of the work done by the two departments is wanting. We would like it to be examined whether such a unified control by one officer, be he of the Forest or Agriculture Department, would improve the matters.

The observed rate of siltation in Hirakud is much higher than the rate assumed during the formulation of the project, and it is feared that the estimated 75 years life of the project may be shortened. An effective handling of the conservation works in the whole project is, therefore, needed. As the bulk of the catchment area lies in Madhya Pradesh, the Union Government should use its good offices to see that conservation work is done effectively in Madhya Pradesh. The Commission noted with some concern that the work of soil conservation in Madhya Pradesh started only three years ago.

15.29 Minor irrigation works in Orissa are under the control of the Ministry of Rural Works, which is also responsible for roads, buildings etc. other than those handled by the Roads and Building Department. On the other hand the major and medium projects are the responsibility of the Irrigation Department. We got the feeling that requisite coordination between the activities of the Rural Works Department and the Irrigation Department is wanting. The activities of the two departments in relation to irrigation are supplementary and we recommend that there should be fuller coordination between the departments during the planning stage of projects.

The Lift irrigation schemes are similarly being looked after by a separate Chief Engineer, who renders technical advice and helps in boring private

tubewells. Here as well we feel that there is need for coordination between different departments dealing with irrigation water.

15.30 Elsewhere in this Chapter we have referred to the variability and undependability of rainfall in some areas of Orissa. We were told that the Palanpur sub-division of Sambalpur district, which was not covered by the Hirakud Project, occasionally suffers from drought due to erratic rainfall. When rains fail or are irregular there are failures of paddy crop. The area affected was reported to be 40,470 hectares. It was suggested to us that there was ample scope for the renovation of derelict tanks and constructing new ones. As an example if the Baganpur tank could be renovated, it would provide irrigation to about 1,620 hectares. Lift irrigation in this area is another possibility.

15.31 At present no water rates are being charged from beneficiaries of irrigation from tanks. They do not bear any portion of expenditure incurred on renovation of tanks. We are given to understand that in the year 1971-72 there was a provision of Rs. 30 million for the work, and for the Fourth Plan it was Rs. 110 million. We see no justification for this favourable treatment. The State officials informed us under the new Irrigation Bill under consideration, the tank irrigation would be assessed to water rates like other irrigation works. We have been given to understand that with the completion of the renovation works, as much as 121,400 hectares of land may be benefited. We urge the necessity of an early revision of the irrigation laws to levy irrigation rates on lands under tanks.

15.32 At Dhenkanal, the farmers referred to heavy damage caused by floods in the Brahmani. The Chief Engineer told us of the proposal to build a storage reservoir at Rengali and that by constructing adequate marginal embankment, it would be feasible to minimise flood damage.

15.33 In the coastal districts, one of the big problems is that of the incursion of sea-water into agricultural lands. In Puri district alone, 20,230 hectares of land is reportedly affected by such incursions. A scheme to provide marginal bunds is said to be under consideration. The farmers expressed their readiness to a betterment levy if they were given protection against incursions by sea-water.

15.34 At the Central Research Station, we found that a number of high-yielding and drought resistant varieties of rice have been evolved. The specialists at the station were of opinion that by adopting the method of intermittent irrigation, submersion being confined to 30 days of flowering and grain-formation period, much saving of water could be effected. They

further thought that by providing an effective system of drainage, the yields of rice may go up by about 20 per cent. This matter is of special importance for the east coastal area, where drainage is sluggish but capable of improvement. We were also told that the rainfall ordinarily during the kharif season in Orissa is sufficient to sustain a crop of kharif rice. For the low rainfall areas susceptible to variability, it was suggested that the 'Bala' variety of rice of 90 days duration may be grown. The 'Padma' variety, which is drought resistant, may prove good for areas with 800 mm of rainfall. These short-duration varieties are harvested during September, October and to protect them against damage by the north-east monsoon, mechanical drying may become necessary.

15.35 The water requirements of rabi rice are high about 122 cm and it should not be grown on areas of low rainfall.

15.36 At our meeting with the Chief Minister and others, the Chief Engineer drew attention to the fact that the full irrigation development of the State would cost Rs. 12,500 million at current prices, but the annual allocation at present was only Rs. 50 million. At this rate it may take well over two hundred years to complete the development. On behalf of the Commission, the Chairman reminded the State Ministers and officers that the water rates in the State were hopelessly low. No betterment levy had been charged from the beneficiaries. On the other hand the land revenue had been recently remitted. We have already made a reference to free irrigation given under tanks which cannot be justified by any standards.

15.37 We have dealt in detail with the water rates and the betterment levy in Chapter XI of the First Volume. Our observations are specially relevant to Orissa where the financial aspects of irrigation have so far been neglected. On the basis of a rough estimate the State is incurring a net annual loss of over Rs. 30 million on irrigation works and unless the water rates are substantially raised, these losses will go on increasing with the construction of new works. If the future works proposed by the State Government are to be implemented in the next 30 years or so, the present policy of levying water rates, betterment levy and other charges will have to be radically altered.

CHAPTER XVI

PUNJAB

Punjab, as reorganized on the 1st of November, 1966, is the fourth smallest State in the Indian Union with an area of 50,260 sq.km. The longest river in the State is the Sutlej which has, as its main tributaries, the Ravi, the Beas and the Chenab. The Ravi and the Chenab join the Sutlej inside Pakistan, while the Beas joins it inside the Punjab. After receiving the waters of these tributaries, the Sutlej joins the Indus which flows into the Arabian Sea.

The Upper Bari Doab Canal, built in 1851 by Dyas of the Bengal Engineers, was one of the earliest important irrigation works and now irrigates about 0.38 million hectares. The Sirhind Canal was another notable work opened for irrigation in 1882, and now irrigates about 1.07 million hectares. The Eastern Canal was constructed between 1927-33, and now benefits an area of about 0.15 million hectares. The giant Bhakra-Nangal Project occupies the pride of place in the irrigation system of the post-Independence era. The Beas Project (Unit I and Unit II) is another giant project, now under construction, to utilize the waters of the Beas.

The population of the State, which, according to the 1971 census, numbers 13.47 millions, is the fifth lowest in India and constitutes about 2.5 per cent of the total population of India. 76 per cent of the population lives in villages, and has agriculture as its mainstay.

The principal crop grown in Punjab is wheat. Other important crops are gram, maize, rice and cotton.

Physiography

16.2 Punjab has two major physiographical divisions, namely, the sub-montane tract and the alluvial plains.

The sub-montane tract is a strip of territory stretching between the Himalayas and the Indo-Gangetic plains, into which the Himalayas throws out spurs. The upper portions of the districts of Gurdaspur, Hoshiarpur and Rupar lie in this strip. Soil erosion is a serious problem in parts of this region.

The plains are part of the Indo-Gangetic plain and comprise the eight

districts of Amritsar, Kapurthala, Jullundur, Ludhiana, Patiala, Sangrur, Bhatinda and Ferozepore and the lower portions of the three districts of the sub-montane tract.

The three principal rivers in the State—the Sutlej, the Beas and the Ravi—are all snow-fed and perennial. They are not navigable. The hydro-potential of these rivers, particularly of the Sutlej and the Beas, is large. After the Sutlej enters Punjab in the Rupar district, the Beas joins it at Harike in Ferozepore district, and the combined stream flows into Pakistan. The Ravi enters Punjab in Gurdaspur district and then flows into Pakistan.

Soils

16.3 The sub-montane region has forest and hill soils, which range from slightly acidic to highly acidic in reaction, and which are in different stages of podsolization. Though rich in humus, they contain very little soluble salts and are somewhat deficient in lime and phosphoric acid. The districts of Ferozepore and Bhatinda have desert soils which not only lack moisture, but are also deficient in organic matter, nitrogen and phosphorus.

The most predominant soil groups in the State belong to the class of Indo-Gangetic alluvium and are found in the remaining area. The soil crust has an average depth of 25 cm. It contains 10 to 15 per cent clay. The crust contains sodium salts and the control of their movement is a major problem. The soils are deficient in nitrogen and organic matter. The alkaline and saline soils are highly deficient in nitrogen, phosphorus and potassium. The problem of salinity and alkalinity is very acute in the districts of Amritsar, Ferozepore and Sangrur and acute in Gurdaspur, Jullundur, Kapurthala, Ludhiana and Patiala districts.

Climate

16.4 Climatically, the year in Punjab can be divided into three major seasons, viz.,

(i) The hot weather season (April to June)
(ii) The rainy season (July to September)
(iii) The cold weather season (October to March)

The hot weather season starts by the end of March, and continues till the end of June. Due to the rise in temperature, there is a drop in atmospheric pressure, and in humidity. The day temperatures, which rise rapidly to 43°C are associated with heat waves. Occasional dust storms, sometimes accompanied by rain, cause sudden falls in temperature.

The rainy season commences in the month of July and lasts till September. It is in this period that the State gets most of its rain. The onset of the monsoon showers brings relief after the prolonged heat of the summer.

The monsoon rains are essential for the growth of kharif crops, and the sowing of the rabi crops.

The cold weather starts in the month of October, and there is a drop in temperature in November. December and January are markedly cold, the temperature going down to 4°C and below. Occasionally, there are winter rains which, though small in quantity, are crucial for traditional rabi crops.

Rainfall

16.5 The south-west monsoon brings rain during the summer months, while the winter rains are caused by depressions formed in areas outside India to the west and north-west, and which move eastwards. The annual rainfall in the plains varies between 400 and 800 mm and in the sub-montane districts between 800 and 1,150 mm. The average rainfall in the two regions of the State in different seasons, is given below:

(Average for 5 years, 1962-66—(mm.)

Season	Sub-montane	Plains
1	2	3
Hot weather season (April to June)	136	68
Rainy season (July to September)	685	427
Cold weather season (October to March)	141	83
Total	962	578

Note : Average for five years 1962-66.

Land Use and Cropping Pattern

16.6 Table 16.1 gives the land utilization statistics for the year 1968-69.

Table 16.2 gives the area under principal crops in 1968-69.

Foodgrains occupy about 68 per cent of the State's total cropped area. Among foodgrains, wheat is the major crop and occupies about 39 per cent of the State's total cropped area. The area under wheat in the State constitutes about 13.2 per cent of the total area under this crop in the country, and the production of wheat is 22.9 per cent of the total production in the country. The State ranks second highest among the wheat-producing States, next to Uttar Pradesh. The other foodgrain crops are gram, maize and rice. Punjab's share in the total production of the country's gram and maize

Table 16.1

Land Use Details—Punjab

Classification	Area (Thousand hectares)	Percentage to the reporting area
1	2	3
Geographical area	5,036	—
Reporting area	5,028	100.0
Forests	114	2.2
Land not available for cultivation	638	12.7
Other uncultivated land excluding fallow land	128	2.5
Fallow land	208	4.1
Net area sown	3,940	78.4
Area sown more than once	1,347	26.8
Total cropped area	5,287	105.2
Percentage of total cropped area to net area sown	—	134.2
Net area irrigated	2,652	
Net area irrigated as percentage of net area sown	—	67.3
Gross area irrigated	3,823	
Gross area irrigated as percentage of gross cropped area	—	72.3

Table 16.2

Principal Crops—Punjab

(*Thousand hectares*)

Crop	Total cropped area
1	2
Rice	344
Bajra	192
Maize	490
Wheat	2,063
Barley	85
Gram	348
Total foodgrains	3,590
Oilseeds	305
Sugarcane	157
Cotton	391
All crops	5,287

is 6.9 and 13.3 per cent respectively. It ranks fifth among the gram-producing and third among the maize-producing States of India.

Among non-food crops, cotton, oilseeds and sugarcane are the major crops. Punjab produces 14.3 per cent of the country's cotton giving her the third position among the States.

Surface Water Resources

16.7 The three principal snow-fed rivers in the State are the Sutlej, the Beas and the Ravi. They traverse the alluvial plains of Punjab in a generally south-westerly direction. The river Ghaggar flows for some distance along the boundary of Punjab and Haryana, also in a south-westerly direction. It is flashy and disappears in the sands of the Rajasthan desert. There are many small hill torrents and Choes which spill out into the plains during the rainy season.

The Sutlej rises in the distant highlands of Tibet at a height of about 4,570 m. from the famous Manasarowar lake. It travels in a very long course through the mountain ranges, which rise to heights of 6,100 m. on either side. The river flows through Himachal Pradesh and emerges from the Siwalik hills at the Bhakra gorge. It then flows as a narrow, deep, stream between low hills for about 16 km and widens into an alluvial river as it flows through Hoshiarpur district. It receives the Beas at Harike above Ferozepore and the Chenab at Madwala in Pakistan. The maximum discharge observed at the Ferozepore Headworks is 25,102 cumecs; while the maximum and minimum discharges of the Sutlej as observed at Rupar are 13,867 cumecs and 78.5 cumecs, respectively.

The Beas rises in the Pir Panjal range at the Rohtang pass at a height of about 3,960 m. A number of tributaries combine to flow across the Dhauladhar range at Larji, and join the Beas just below Mandi. From its source to its confluence with the Sutlej, the river has a length of about 467 km. The maximum and minimum discharges observed at Dera Gopipur in 1942 were about 9,905 cumecs and 60.3 cumecs respectively.

The Ravi rises near the Rohtang pass in Kangra district and drains the southern slopes of the Dhauladhar. After crossing the Siwaliks, it enters the Punjab plains at Madhopur. From its source to the Indo-Pakistan border, the river has a length of about 370 km. The maximum and minimum discharges recorded at Madhopur in 1947 were between 15,565 and 16,980 cumecs and 34.4 cumecs. The river passes into Pakistan about 26 km. below Amritsar.

16.8 A Discharge Division working under an Executive Engineer observes the discharge data in the State.

The Division maintains the records of river gauging in the State for the

last 60 years. But, the data have not been published. The mean annual run-off figures for the 3 major rivers are as below:

Sutlej at Bhakra	15,801 m.cu.m.	(12.81 MAF)
Beas at Mandi Plain	15,961 m.cu.m.	(12.94 MAF)
Ravi at Madhopur	7,993 m.cu.m.	(6.48 MAF)

Ground Water Resources

16.9 Punjab possesses large resources of ground water suitable for irrigation, except in some areas like the district of Bhatinda and some parts of Ferozepore and Amritsar districts where the sub-soil water is saline. A large-scale programme of exploiting ground water through tubewells/pumping sets can be undertaken without any risk of depleting the aquifers, which are regularly recharged from the perennial rivers, and canals and from rainfall. An area of about 0.6 to 0.8 million hectares, suffers from waterlogging. The tubewells would not only provide assured irrigation for intensive cropping, but would also to some extent, ease waterlogging.

An assessment of the surface water potential shows that the present utilization of water in Punjab from canals is about 12,335 m.cu.m. In addition, by the end of 1968-69, about 3,392 m.cu.m. of ground water would have been drawn annually by State and private tubewells/pumping sets and dug wells. Considering the recharge from rainfall, rivers and canals, the total estimated ground water potential which can be safely drawn on a sustained basis, is estimated to be about 11,101 m.cu.m. (9 MAF), a quantity sufficient for about 0.3 million tubewells/pumping sets and dug wells. The State should be in a position to install an additional 0.2 million tubewells during the Fourth Plan period to provide assured irrigation to about 0.6 million hectares. The State Electricity Board proposes to energize 0.127 million tubewells during the Fourth Five Year Plan.

A programme for ground water studies in Punjab, which includes the mapping of aquifers, has been recently sanctioned by the Punjab Government.

It is proposed to drill 180 exploratory bore holes, each 60 to 90 m. deep in a grid covering the State. Sixty pumping tests to determine aquifer characteristics and the laboratory analysis of 35,000 soil and 4,000 water samples will also form part of the programme. The geological data provided by the exploratory bore holes will be used for mapping the aquifers while the laboratory tests on sand and water samples will help to determine the nature of the aquifers and quality of ground water.

The State Government propose to undertake the construction of deep bore tubewells in the sub-montane areas to provide irrigation to 0.13 million hectares.

Present Stage of Development of Irrigation

16.10 One of the earliest irrigation works constructed in Punjab was the Bari Doab Canal. After the construction of the Lower Bari Doab Canal in 1907-1913, the Bari Doab Canal was renamed the Upper Bari Doab Canal. The Bari Doab Canal was opened in 1859 without any permanent headworks or distributary channels and the temporary weir made of wooden crates and filled with boulders had to be re-constructed every year after the floods. In 1868 the construction of a permanent headworks at Madhopur was undertaken, and it was commissioned in 1876. The project was again revised in 1874 to provide a properly designed distribution system.

On Partition sizeable portions of the area irrigated by this canal and its channels, fell to the share of Pakistan. In India, irrigation under the canal is now restricted to Gurdaspur district. According to the latest available figures the canal irrigated an area of 0.385 million hectares.

Another notable project was the Sirhind Canal built in 1873. It was the first project to be financed from public loans and to be constructed wholly by a Government agency. Opened for irrigation in 1882 to serve areas in British Punjab and the former Princely States of Patiala, Nabha, Jind, Faridkot, Malerkotla and Kalsia—it was an excellent example of inter-State co-operation.

The Sirhind Canal takes off from the Sutlej at Rupar, about 80.5 km. downstream of the Bhakra Dam. In 1954, as a part of the Bhakra-Nangal Project, the weir on the river was replaced by a barrage, providing complete control of the river supplies at all levels. Another canal known as the Bist Doab Canal was constructed to irrigate areas on the right bank of the river.

The Sirhind Canal, in its head reach, crosses two large hill torrents, the Budki and the Siswan, which are carried over the canal by means of viaducts. It irrigated an area of 1.07 million hectares.

The great Eastern Canal from the Sutlej was constructed in Punjab between the years 1927-33. It benefits an area of 0.148 million hectares in Ferozepur district.

16.11 The State as well as the Union Government have laid great emphasis on irrigation and power development, and a number of works were taken up immediately after Independence, including the Bhakra-Nangal Project, the Harike Project, the Beas Project, Unit-I (Beas-Sutlej Link) and Unit-II (Pong Dam). Table 16.3 gives a list of projects costing more than Rs. 10 million each, undertaken since 1951.

The Bhakra-Nangal and Beas Projects have been briefly described earlier in the Haryana State Chapter.

Table 16.3

Projects Costing More Than Rs. 10 Million Each Undertaken Since 1951

(*Rs. million*)

Project	Cost
1	2
Bhakra-Nangal Project (completed)	1,751.44
Raising and strengthening the banks of channels (completed)	11.49
Harike Project	91.45
Beas Project (as a whole)—Unit I	1,468.70
—Unit II	1,676.70

Wells and Tubewells

In 1966-67, of the total irrigated area of 2.28 million hectares (net), 1.01 million hectares or 44 per cent was irrigated by minor irrigation works like wells, tubewells/pumping sets etc. i.e., by utilizing ground water, and 1.27 million hectares or 56 per cent by canals. The area irrigated by ground water rose to 1.04 million hectares in 1967-68, and was expected to reach 1.19 million hectares in 1968-69. Since now only limited scope remains for increasing the area under major and medium irrigation works from surface flows, irrigation in un-irrigated areas and the firming up of irrigation in some existing irrigated areas in Punjab, will have to depend primarily on the tapping of ground water.

The net area irrigated from different sources in 1968-69 was as follows:

Table 16.4

Source-wise Irrigation in Punjab

(*Thousand hectares*)

Source	Area irrigated
1	2
Government canals	1,290
Private canals	4
Tanks	—
Wells & tubewells	1,352
Other sources	6
Total	2,652

The gross area irrigated is 3,823 thousand hectares.

The salient features of works irrigating over 4,000 hectares each, are given in Appendix 16.1.

Ayacut Development

16.12 Depending on the type of soil, it has been estimated that 25 to 70 per cent of irrigation water is being wasted through seepage in conveyance channels. This seepage leads to waterlogging and salinity. By proper water management and land grading, it should be possible to irrigate an additional 25 per cent to 70 per cent of area with the same quantity of water.

Up to the end of the Second Plan, there was little or no soil conservation or water management in the State. Some preliminary steps to educate the farmers in soil and water management, channel lining, land levelling and soil conservation methods were taken up during the Third Plan. During the first two Annual Plans (1966-68), an area of 33,600 hectares was covered by this programme. It was proposed to cover an additional area of 11,000 hectares in 1968-69.

The programme for the Fourth Plan in water management and soil conservation, includes:

(a) The provision of suitable water conveyance systems; land grading, field drainage and conservation irrigation, in an area of 0.106 million hectares;
(b) Contour bunding, terracing, check-dams, gully plugging, and excess water channels in an area of 0.020 million hectares;
(c) A land-use and soil survey of 0.216 million hectares;
(d) Preliminary surveys by the Survey and Investigation Sub-divisions of the State Irrigation Department, to expedite the execution of projects for field drainage;
(e) Training of staff in soil and water conservation.

It is also proposed to make soil and water management works obligatory, in the case of all tubewells to be installed with the special financing facilities advanced by the Agricultural Refinance Corporation.

We would draw the attention of the State Government to our recommendations for ayacut development in Chapter VII of Volume I of our report.

Future Development of Irrigation

16.13 Of the three rivers serving the State, the waters of the Sutlej have already been fully exploited by the construction of the Bhakra-Nangal Project. Work on the Beas Project (Units I & II) is in full swing, and, when

it is completed, practically all the water available in the river will have been tapped. Only the waters of the Ravi, which are around 7,808 m.cu.m. (6.33 MAF) will remain to be utilized. There is a proposal for a project to provide irrigation, power, flood control, recreation facilities and pisciculture, which envisages the construction of a 147 m. high thick-core gravel shell dam across the river Ravi near the village of Thein in Jammu and Kashmir State. The left bank of the river at the dam site falls in Punjab State, while the right bank falls in Jammu & Kashmir State. The dam site is about 24 km by road from the Madhopur Headworks. A power plant will be built near the Thein Dam. The construction of the dam is considered to be essential for the total utilization of the irrigation and power potential of the Ravi. The additional supplies which will be available on the completion of the dam, will be utilized for improving the capacity factor and water allowance to existing areas, and for extending irrigation to new areas. It has been estimated that there will be an increase of 348,657 hectares of annual irrigation, and the project will yield a total firm power of 315 MW at 60 per cent load factor.

Very limited scope remains for irrigation in the State, through major and medium irrigation projects. The main schemes proposed to be taken up during the Fourth Plan are given below:

(1) Utilization of the surplus Ravi-Beas waters;
(2) Extension of non-perennial irrigation to areas in the U.B.D.C.* tract;
(3) Sinking of tubewells in the U.B.D.C. tract for stabilizing and augmenting supplies in winter.

Utilization of Surplus Ravi-Beas Waters

This scheme has been formulated to synchronise with the completion of the Beas Project, so that stored water and also supplies which will no longer need to go to Pakistan under the Indus Water Treaty, can be utilized for irrigation. It has two components—(a) the construction of a link from the Sutlej to the Narwana Branch in Haryana, and (b) the extension and remodelling of the existing Bhakra and Sirhind systems. The project will create a total irrigation potential of 81,000 hectares during the Fourth Plan period.

Extension of Non-perennial Irrigation to Area in the U.B.D.C. Command

It was decided, to use 2,467 m.cu.m. out of the total water of the river in the U.B.D.C. tract. The anticipated irrigation would cover 0.146 million hectares.

*U.B.D.C. is Upper Bari Doab Canal.

Sinking of Tubewells in the Upper Bari Doab Canal (U.B.D.C.) Tract for Stabilizing and Augmenting the Supplies in Winter

During the rabi season, the water available from the Ravi is hardly sufficient to meet 25 to 50 per cent of the irrigation requirements of the U.B.D.C. Even after the full utilization of Ravi waters, i.e., after the construction of the Thein Dam, the position in this tract will not improve beyond a 0.4 to 0.6 capacity factor against the 0.8 to 1.00 capacity factor needed to mature the rabi crop. It is therefore proposed to install about 300 deep tubewells along the U.B.D.C. tract to augment canal flows in the winter, and to guard against an undue rise in the sub-soil water-table. This scheme would provide irrigation to about 40,000 hectares of land.

The future potential for irrigation development in Punjab from all sources comes to 1.22 million hectares. On the development of this potential, the total irrigation in the State will come to about 5.04 million hectares. This will work out to about 95 per cent of irrigation to the gross cropped area.

Table 16.5 indicates in brief the final picture of irrigation development in Punjab, subject to final allocation of Ravi-Beas waters.

Table 16.5

Ultimate Irrigation Potential—Punjab

(*Million hectares*)

Item	Major and Medium projects	Minor irrigation works *	Total
1	2	3	4
Area irrigated in 1969	1.86	1.96	3.82
Additional area that will be brought under irrigation on completion of projects under execution * *	0.62	0.60	1.22
New Projects	N.A.	N.A.	N.A.
Total	2.48	2.56	5.04

*Includes tubewells

* *Includes Thein Dam.

Floods, Waterlogging and Drainage

16.14 The flood problem in the State is aggravated by the sudden change in gradient, as the rivers emerge from steeply sloping mountain valleys into gently sloping plains. Almost every year, floods in the State cause damage to life and property, and destroy crops over wide areas. The

damage caused by floods to crops and property in the reorganized State of Punjab is given below:

Year	Rs. million	Year	Rs. million
1955	310.15	1961	47.7
1956	9.8	1962	310.9
1957	19.3	1963	5.9
1958	203.3	1964	152.0
1959	17.9	1965	0.2
1960	123.0	1966	91.6
		1967	27.0

The recurrence of floods has a direct bearing on the extent of waterlogging in agricultural lands. Apart from seepage from irrigation canals and irrigated lands, there are other important factors contributing to the rise of ground water, such as the interference caused by embankments of canals, roads, railways, etc.. The continued deforestation of the hills cause frequent flash floods in rivers, hill torrents and Choes which submerge cultivated area. The total waterlogged* area in the month of October, during various years is given below:

Year	Area in hectares	Year	Area in hectares
1951	363,722	1958	1,103,400
1955	327,363	1959	1,017,446
1956	869,900	1962	1,323,506
		1964	970,787

Large extents of land had became saline and alkaline.

An Action Committee, set up to suggest measures for the control of floods and waterlogging, recommended the following measures:

(a) minimization, if not total prevention, of flooding by rivers, big streams and creeks;
(b) improvement of surface drainage;
(c) lining of water courses, main canals and distributaries, if this can be done at reasonable cost;
(d) installation of an adequate number of tubewells, and the revival of percolation wells which had fallen into disuse, to stabilize the subsoil water at the proper level;

* When water-level rises to 1.7 m of the surface, there is waterlogging.

(e) increase in the water allowance in 'Thur' affected areas so as to attain an intensity of 200 per cent;
(f) a proper crop rotation, including the use of green manure, and
(g) construction of seepage drains, parallel to existing channels.

It has been assessed that flood control and drainage schemes in the State would cost about Rs. 800 million, and anti-waterlogging measures about Rs. 400 million.

The achievements up to 1968-69, and the targets proposed for the Fourth Plan in respect of flood control, drainage and anti-waterlogging schemes are given below:

(i) Flood control and drainage	Bunds	Drains
Total length of embankments and drains required to be constructed in the re-organized Punjab State	603 km. besides, 282 km. reclamation and flood protection bunds will be constructed along the river Sutlej from Rupar to Harike.	10,780 km.
Length likely to have been constructed by the end of 1968-69	410 km. length of bunds including replenishing the old bunds. Besides, 249 km. reclamation bunds constructed along the Sutlej	4,505 km. drains in pilot intermediary stages.
Length likely to be constructed in the Fourth Plan	48 km. of bunds and replenishing the bunds previously constructed. Besides, 32 km. remaining length of reclamation and flood protection bunds along the river Sutlej to be constructed.	1,006 km. new drains and enlarging the capacity of drains and completing other components of schemes spilling over to the Fourth Plan.

(ii) Anti-waterlogging	(million hectares)
(a) Total catchment area to be benefited in the reorganized Punjab	3.66
(b) Catchment area benefited during the Second and Third Plans	1.46

	(million hectares)
(c) Catchment area likely to have been benefited during 1966-67 to 1968-69	0.20
(d) Catchment area likely to be benefited in Fourth Plan	0.73
(e) Spill over.	1.27

The works carried out by the State so far, have already yielded beneficial results. Flood damages have been reduced and the water-table has been kept under check. The large number of shallow tubewells sunk by the farmers have assisted in keeping the water-table down. One of the Members of the Commission visited the drainage works carried out near Patiala and was impressed with the results achieved. Large extents of saline and alkaline lands are waiting for reclamation which will be possible when more water becomes available for flushing. The Commission commends the example of the vigorous action taken by Punjab to other States where such remedial measures are called for.

Water Rates

16.15 The assessment of revenue from canals, tubewells and other irrigation works is governed by Sections 33-39 and 44 of Part V of the Northern India Canal and Drainage Act, VIII, 1873, as amended from time to time.

The rates applicable on some of the important canal systems in the State w.e.f. 1.4.1953, are as below:

The Upper Bari Doab Canal

Name of crop	Rate per hectare (acre) of flow irrigation (Rupees)
1	2
(a) *Kharif*	
(i) Rice	24.30 (9.83)
(ii) Cotton	16.80 (6.81)
(iii) Maize	14.01 (5.67)
(iv) Indigo	20.56 (8.32)
(v) Fodder	9.34 (3.78)
(vi) Vegetables	20.56 (8.32)
(vii) Sugarcane	33.63 (13.60)

Name of crop	Rate per hectare (acre) of flow irrigation (Rupees)
1	2
(viii) Other kharif crops	16.80 (6.80)
(ix) Fibres	16.80 (6.80)
(x) Tobacco	20.56 (8.32)
(xi) Drugs	20.56 (8.32)
(xii) Wheat	6.87 (2.78)
(xiii) Gram	6.87 (2.78)
(xiv) Poppy	20.56 (8.32)
(xv) Spices	20.56 (8.32)
(xvi) Other dyes	20.56 (8.32)
(xvii) Oilseeds	15.89 (6.43)
(xviii) Bajra	12.13 (4.92)
(xix) Jowar & Chanagram which have received two or more waterings and all fodder crops including turnips	3.75 (1.52)
(xx) Watering for ploughing not followed by a crop in the same or succeeding harvest	3.75 (1.52)
(xxi) Any number of waterings in kharif	3.75 (1.52)
(xxii) A single watering in kharif or rabi for gram	3.75 (1.52)
(b) *Rabi*	
(i) Wheat	14.63 (5.14)
(ii) Waternuts	28.02 (11.33)
(iii) Gram	11.12 (4.39)
(iv) Other crops including grass given two or more waterings	7.48 (3.03)
(v) Barley	15.86 (6.42)
(vi) Oats	15.86 (6.42)
(vii) Fodder	7.48 (3.03)
(viii) Vegetables	7.48 (3.03)
(ix) Melon	16.80 (6.75)
(x) Masur	12.14 (4.90)
(xi) Pulses	12.14 (4.90)
(xii) One watering in rabi	3.76 (1.52)
(xiii) Two or more waterings in rabi or kharif	7.48 (3.03)
(xiv) Paddock areas sanctioned by local Govt.	20.39 (8.25)

Name of crop	Rate per hectare (acre) of flow irrigation (Rupees)
1	2
(c) *Perennial*	
(i) Sugarcane	41.08 (10.62)
(ii) Orchard (½ yearly)	20.56 (8.31)
(iii) Garden (½ yearly)	20.56 (8.31)

General Remarks: Rates for lift irrigation is half the rate for flow irrigation.

Note 1—Hemp, Indigo and Jantar ploughed in as green manure before 15th September, are not assessed to water rates.

2—Additional charges will be levied on Sirhind and U.B.D.C. with effect from rabi 1950-51, if any extra watering is allowed after 31st October, as follows:

Rate per hectare (acre) Rs.

Flow	Lift	
2.27 (1.12)	1.38 (0.56)	Except for fodder crops including turnips.
1.38 (0.56)	0.69 (0.28)	For fodder crops including turnips.

Sirhind Canal

(a) *Kharif*	
(i) Rice	24.09 (9.75)
(ii) Cotton	16.68 (6.75)
(iii) Maize	15.75 (6.37)
(iv) Indigo	20.39 (8.35)
(v) Fodder	9.26 (3.75)
(vi) Vegetables	20.39 (8.25)
(vii) Sugarcane	8.65 (3.50)
(viii) Other kharif crops	18.53 (7.50)
(ix) Fibres	18.53 (7.50)
(x) Tobacco	20.39 (8.25)
(xi) Drugs	20.39 (8.25)
(xii) Gram	6.80 (2.75)
(xiii) Wheat	6.80 (2.75)
(xiv) Spices	20.39 (8.25)
(xv) Other dyes	20.39 (8.25)
(xvi) Bajra	12.03 (4.87)

(xvii)	Jowar & Chanagram which have received two or more waterings in all fodder crops including turnips	9.26 (3.75)
(xviii)	Watering for ploughing not followed by a crop in the same succeeding harvest	3.71 (1.50)
(xix)	Any number of watering in kharif	3.71 (1.50)

(b) *Rabi*

(i)	Wheat	14.36 (5.81)
(ii)	Waternuts	27.80 (11.25)
(iii)	Gram	11.05 (4.47)
(iv)	Other crops	7.41 (3.00)
(v)	Barley	15.74 (6.37)
(vi)	Fodder & vegetables	7.41 (3.00)
(vii)	Garden	7.41 (3.00)
(viii)	Oats	15.74 (6.37)
(ix)	Orchard (½ yearly)	7.41 (3.00)
(x)	Melon	7.41 (3.00)
(xi)	Masur	18.53 (7.50)
(xii)	Pulses	4.62 (1.87)
(xiii)	One watering in rabi	3.71 (1.50)
(xiv)	Two or more waterings in rabi	7.41 (3.00)
(xv)	Oilseeds	15.74 (6.37)

(c) *Perennial*

(i)	Sugarcane	40.77 (16.50)
(ii)	Orchard & vegetables excepting turnips (½ yearly)	20.39 (8.25)
(iii)	Garden (½ yearly)	20.39 (8.25)

General Remarks: Rate for lift irrigation is half the rate for flow irrigation.

Additional charges: An additional charge specified below will be levied on the Sirhind and Upper Bari Doab Canals with effect from rabi 1950-51 if any water is allowed after 31st October.

Rate per hectare (acre) Rs.

Flow	Lift	
2.77 (1.12)	1.38 (0.56)	Except for fodder crops including turnips only.
1.38 (0.56)	0.69 (0.28)	For fodder crops including turnips.

Sirsa Branch (extended area), Bhakra Main Branch, Fatehabad Branch, Rohri Branch, Ratia Branch, Ottu Feeder, Narwana Branch, Samrala and Govindgarh System, Nangal Hydel Channel, Bist Doab Nawashahar Branch, Jullundur Branch, Sarusti Canal, Ghaggar Canal of Bhakra Canals.

Name of crop	Rate per hectare (acre) of flow irrigation (Rupees)
1. Rice	24.09 (9.75)
2. Cotton	16.68 (6.75)
3. Maize	15.74 (6.37)
4. Indigo	20.39 (8.25)
5. Sugarcane except on kharif channels	40.77 (16.50)
6. Sugarcane on kharif channels	33.36 (13.50)
7. Waternuts	27.80 (11.25)
8. Gardens, orchards and vegetables (except turnips)	20.39 (8.25)
9. Barley and oats (except on kharif channels)	15.74 (6.37)
10. Wheat (except on kharif channels)	14.43 (4.84)
11. Oilseeds (except on kharif channels)	15.74 (6.37)
12. Melon, fibres (other than cotton)	18.52 (7.50)
13. All rabi crops except wheat and gram on kharif channels (including gardens, orchards, vegetables and fodder)	7.41 (3.00)
14. Wheat and gram on kharif channels	6.81 (2.75)
15. Bajra, masur and pulses	12.03 (4.87)
16. Gram	11.05 (4.47)
17. Jowar, chana, grass which has two or more waterings and all fodder crops including turnips	9.27 (3.75)
18. (a) Watering for ploughing not followed by a crop in the succeeding harvest	3.71 (1.50)
(b) Village and District Board plantations;	
(i) Any number of waterings in kharif	3.71 (1.50)
(ii) One watering in rabi	3.71 (1.50)
(iii) Two or more waterings in rabi	7.41 (3.00)
(c) Grass given two or more waterings in kharif or rabi	3.71 (1.50)

Note 1—Grass given two or more waterings falls under Class XI. Hemp, indigo, guara, jantar and aahar ploughed in as green manure before the 15th September, are not assessed to water rates.

2—An additional charge will be levied if any extra water is allowed after 31st October, on kharif channels.

Additional Rate per hectare (acre) Rs.

Flow	Lift	
2.77 (1.12)	1.38 (0.56)	Except for fodder crops including turnips
1.38 (0.56)	0.69 (0.28)	Fodder crops including turnips only.

Water rates for irrigation from State tubewells are now being charged at 25 paise per unit (Kilowatt) of electricity consumed, irrespective of the crop grown. In the case of lift from canals when the lift is provided by the cultivators at their own expense, the water rates charged are at half the flow rates. If the lift is provided at Government expense, the water rates charged are double the flow rates.

Betterment Levy

16.16 Where the revenue from water rates in any project is insufficient to cover its operational costs, a betterment levy is chargeable under the Punjab Betterment and Acreage Act of 1952. According to the Act, the betterment fee should be such as to make up the losses in the project, provided that it does not exceed half the value of the land benefited by the project. It is to be finally recovered on the basis of the C.C.A., though at present it is being levied on the matured area basis due to the advance recovery of betterment charges. The levy can be paid in a lump sum or in 30 half-yearly instalments or by the surrender of land in lieu of full or part payment.

Pending the finalization of betterment levy schedules, the Punjab Government has levied the betterment charges in advance, on the basis of the matured area, under the Bhakra-Nangal Project. The advance levy for the kharif harvest of 1958 was at rates not exceeding Rs. 23/- per matured acre. The actual rates of betterment levy are given in the table below. (These rates were reduced by 50% for the kharif of 1960).

	Rate per matured hectare (acre)	
	Gravity flow irrigation hectare (acre)	Lift irrigation maintained and operated by land owners hectare (acre)
	Rs.	Rs.
1. Areas which will ultimately receive perennial irrigation	24.71 (10.00)	12.36 (5.00)
2. Areas which will ultimately receive non-perennial irrigation	12.36 (5.00)	6.18 (2.50)

	Rate per matured hectare (acre)	
	Gravity flow irrigation hectare (acre)	Lift irrigation maintained and operated by land owners hectare (acre)
3. Areas which will ultimately receive restricted perennial irrigation	18.53 (7.50)	9.27 (3.75)
4. Areas where water allowance is ultimately to be increased	6.18 (2.18)	3.09 (1.25)
5. Areas where non-perennial irrigation is ultimately to be converted into perennial irrigation	12.36 (5.00)	6.18 (2.50)
6. Areas where non-perennial irrigation is ultimately to be converted into restricted perennial irrigation.	6.18 (2.50)	3.09 (1.25)

The Government has realised advance betterment levy amounting to Rs. 60.61 million up to 30.9.1966. However, the Punjab Government passed orders on 17.7.1967 to discontinue the collection of betterment levy, and the levy has not yet been reimposed.

Punjab is a typical example of how irrigation can transform areas that would otherwise be classified as drought affected. According to meteorological criteria laid down by us in Chapter VIII of Volume I, large portions of Punjab should have been normally categorised as drought affected but the extensive network of canals has made these areas green and prosperous and so these areas are not considered as drought affected.

CHAPTER XVII

RAJASTHAN

Rajasthan is the second largest State in the Indian Union, with an area of 342,214 sq. km. The Luni, Mahi, Sabarmati, Chambal and Banas rivers flow through the State, the first three draining into the Arabian Sea and the last two joining the Yamuna.

Rajasthan having been made up of several Princely States and principalities which merged into the Indian Union after Independence, few details are known of the development of irrigation prior to the merger. The earliest important irrigation work seems to have been the Raj Samand tank on the Gumti Nadi in the district of Udaipur, built in 1861 and renovated in 1950-51. In the absence of big rivers, wells, tanks and *rapats* (small masonry weirs to hold rain water) were the chief sources of irrigation. The first really important irrigation work taken up in what now comprises Rajasthan, was the Gang Canal, constructed during the period 1922-1927 to irrigate lands in the former Princely State of Bikaner. During the last 20 years, the State Government has given the highest priority to irrigation, without which the economy of this semi-arid to desert land cannot be developed. The provision of irrigation supplies from the Bhakra Dam, and the construction of the Jawai Dam across the river Jawai have added to the State's irrigation potential. The Chambal Project across the river Chambal has almost reached completion. The Rajasthan Canal now under construction ranks among the biggest in the world.

The population of Rajasthan according to the 1971 Census was 25.7 millions or 4.7 per cent of India's total population. In population, Rajasthan ranks tenth among the States. Its density of 75 per sq. km. is the third lowest in India.

Animal husbandry and agriculture are the main occupations of the people. Out of the total population of 25.7 million, 6.0 million are engaged in agriculture and 82 per cent of the people live in villages.

The principal crop grown in Rajasthan is bajra. Other important crops are gram, jowar, wheat, maize and sesamum.

Physiography

17.2 The State can be divided into the following physiographic divisions:

(1) Aravalli Range and the Hill Region
(2) Western Sandy Plains
(3) Eastern Plains and
(4) South-eastern Pathar (Hadoti plateau)

The Aravalli Range is the dominant mountain range of Rajasthan, and forms the watershed between the catchments of streams flowing into the Arabian Sea and those flowing through the Yamuna into the Bay of Bengal. Though not uniform in width, the range runs diagonally across the State from the north-east near Delhi for a distance of 692 km. to the south-west up to the plains of Gujarat. Within Rajasthan, it runs from Khetri in the north-east, to Khed-Brahma in the south-west, about 500 km. from Delhi. Near Khetri it becomes more prominent and forms well-marked ranges to the west of the Sambhar Lake. The lake itself is an important basin of interior drainage, occupying an area of about 145 sq. km. It is the major source of salt to north India. From Ajmer onwards the Aravalli Range has a width of 50 km. and begins to throw out spurs to the south and south-east towards Udaipur and Dungarpur. It has a higher elevation in the south-west, and the Gurushikhar peak at Mount Abu rises to 1,727 metres above M.S.L.

The plains to the west of the Aravalli form the western sandy plains. This is a sandy, semi-arid to arid region. The principal drainage in this area is the Luni with its tributaries. Large areas of Bikaner, Jodhpur and Jaisalmer districts lie in this region. The monotony of the desert is broken by isolated patches of scrub jungle and stunted vegetation. There are also numerous small hillocks dotting the area. The Eastern Plains lie to the east of the Aravallis and are drained by the Banas river. The south-eastern Pathar comprises the Vindhyan scarpland and the Deccan lava plateau. It covers the districts of Chittorgarh, Kota, Bundi and Jhalawar. Alluvial soils occur in the north-eastern and central parts of this area, while the south-eastern part is rocky with a thin soil cover.

The mean elevation of the State ranges between 214 and 1,300 m., the major portion of the State being less than 370 m. above M.S.L.

Soils

17.3 The soils of Rajasthan can be divided into the following seven categories:-

(i) Desert soil,
(ii) Grey and brown (desert) soil,
(iii) Red and yellow soil,
(iv) Ferruginous red soil,
(v) Mixed red and black soil,

(vi) Medium black soil, and
(vii) Alluvial soil.

The desert soil occupies the largest area. The whole of the State west of the Aravallis up to the international border with Pakistan is covered by sand dunes. The soil contains about 90 to 95 per cent sand and about 5 to 7 per cent clay. Phosphates, together with nitrates, make these desert sands potentially fertile for growing agricultural crops and plants if water were available. But since water is scarce, the entire tract remains unproductive.

Grey and brown (desert) soil occurs in the districts of Barmer, Jhalawar, Jodhpur, Sirohi, Pali, Nagaur, Sikar and Jhunjhunu. The whole of this area lies west of the Aravallis and is characterised by vast stretches of sandy plains, broken at places by hillocks and rock outcrops. The fertility of the soil, which is saline and alkaline, increases towards the east and north-east.

Red and yellow soil occurs in the western parts of the districts of Udaipur, Bhilwara and Ajmer. Silty loams to silty clay loams are common. It has good moisture holding capacity.

Ferruginuous red soil occupies the central and southern part of the Udaipur district and the whole of the Dungarpur district. Compared to the heavy and medium black soils, it has a lower content of lime, potash, iron oxide and phosphorus. In different areas the red soil varies greatly in depth and fertility. It is of lighter texture, porous and friable in structure and invariably free from 'kankar' nodules.

Mixed red and black soil is found in the eastern parts of the districts of Udaipur, Chittorgarh, Dungarpur, Banaswara and Bhilwara. The pH value of the soil is neutral to alkaline. Medium black soil is mostly found in the districts of Kota, Bundi and Jhalawar in the south-eastern part of the State. The soil in this region is black and deep. On the basis of the colour on the surface, the soils in this region have been grouped into heavy soil, medium heavy soil and red and yellow soil.

Alluvial soil occupies the north-eastern part of the State, comprising the districts of Alwar, Bharatpur, Jaipur and Sawaimadhopur and the central part of the Ganganagar district. It is red in colour and deficient in lime, phosphoric acid and humus. It varies in texture from clayey to sandy loam. In some parts it contains kankar, which lies either in sands or sandy clays, sometimes holding gravel. This soil produces a wide variety of crops including wheat, rice, cotton and tobacco.

Climate

17.4 The State has three major seasons viz. (i) the hot weather (March to mid-June), (ii) the rainy season (mid-June to September) and (iii) the cold weather (October to February). The climate of Rajasthan, west of the

Aravallis, as of other desert and semi-desert regions, is characterised by great extremes of temperatures, long periods of severe drought, accompained by high winds and low to semi-arid conditions of humidity. The winter is quite cold and at places the temperature sometimes falls below freezing point. The heat during the summer is intense and scorching with the temperature touching 48°C (118°F). In the east and south of the Aravallis there is considerable variation in the amount of rainfall and range of temperature. Climatically speaking, Rajasthan is the driest State in the country. Due to the Sandy nature of the soil, which gets rapidly heated during the day and cools down quickly after dusk, differences of as much as 22°C (72°F) have been noted between maximum and minimum temperatures.

Rainfall

17.5 Rajasthan receives rain from both the Arabian Sea and the West Bengal branches of the south-west monsoon, and 80 to 90 per cent of the rain in the State is precipitated in the period from June to September. The 50 cm. isohyetal line which runs along the western edge of the Aravalli range divides the State into two parts. To the east and south of this line, the rainfall gradually increases, whereas to the west it rapidly decreases. On an average the State receives 53.6 cm. of rainfall, but there are wide variations in its distribution. Jaisalmer and Bikaner in the west receive hardly 17 and 29 cm. of rain respectively while Banswara and Jhalawar in the east receive about 93 cm.

Some rain is accompanied by local thunder storms. Jhalawar and Jaipur have 40 to 45 days of thunder storms in a year while Ajmer and Kota have 30 to 45 days, Jodhpur has about 20 days whereas Bikaner and Barmer have only about 10 days. Ganganagar rarely experiences thunder storms.

Land Use and Cropping Pattern

17.6 Table 17.1 gives the land utilization statistics for Rajasthan for the year 1968-69.

Table 17.2 gives an idea of the crops grown in the State during the year 1968-69.

It will be seen that foodgrains occupy about 78 per cent of the total cropped area. Among foodgrains, bajra is the major crop and occupies about 32 per cent of the total cropped area. The area under bajra in the State constitutes about 36.6 per cent of the area under bajra in the country. The State produced (average of 1967-68 to 1969-70) 21.5 per cent of barley, 15.4 per cent of gram and 12.3 per cent of maize of the total production of these crops in the country.

Table 17.1

Land Use Details—Rajasthan

Classification	Area in thousand hectares	Percentage to the reporting area
1	2	3
Total geographical area	34,222	
Reporting area	34,043	100.0
Forests	1,236	3.6
Barren and unculturable land	4,760	14.0
Land put to non-agricultural uses	1,171	3.4
Culturable waste	6,293	18.5
Permanent pastures and other grazing lands	1,828	5.4
Land under misc. tree crops and groves not included in the net area sown	14	—
Current fallows	3,114	9.1
Other fallow lands	2,316	6.8
Net area sown	13,311	39.1
Area sown more than once	946	2.8
Total cropped area	14,257	41.9
Net irrigated area	2,119	6.2
Gross irrigated area	2,545	7.5
Percentage of net area irrigated to net area sown		15.9
Percentage of gross irrigated area to gross area sown		17.9

Surface Water Resources

17.7 The drainage system in Rajasthan is largely determined by the existence of the Aravallis; the great Indian watershed which divides the drainage to the Bay of Bengal on one side and the Arabian Sea on the other.

The most characteristic feature of the drainage system is that nearly 60 per cent of the area of the State lying west of the Aravallis, is an inland drainage system due to scanty rainfall and sandy terrain. Except the Luni river and its tributaries which drain the western slopes of the Aravallis, there is hardly any river worth mentioning in the western region. This is because the scanty rainfall ranging from 10 to 25 cm. is absorbed by the sandy soil.

Broadly speaking there are three main drainage systems:

(i) The Luni river with its tributaries which drain the western slopes of the Aravallis and flow into the Arabian Sea.

Table 17.2

Crops Grown in Rajasthan—1968-69

Crop	Area in thousand hectares	Percentage to total cropped area
1	2	3
Rice	129	0.9
Jowar	947	6.6
Bajra	4,555	31.9
Maize	796	5.6
Wheat	1,159	8.1
Barley	497	3.5
Other cereals & millets	68	0.5
Gram	999	7.0
Other pulses	1,969	13.8
Total food grains	11,145	78.2
Sugarcane	38	0.3
Groundnut	295	2.1
Sesamum	525	3.7
Rape and mustard	121	0.8
Linseed	48	0.3
Cotton	263	1.8
Fodder crops	1,607	11.3
Total cropped area	14,257	100.0

(ii) The Mahi and Sabarmati rivers which drain the eastern slopes of the Aravallis and flow into the Arabian Sea.

(iii) The Chambal river and its tributaries, the Kalisindh, Parwan and Parwati on the right bank and the Banas and its tributaries the Khari, Mashi, Morel, Berach on the left bank.

Hydrological Observations

17.8 A Hydrology Unit in the Irrigation Department of the State records the rainfall and assesses the surface water resources of the State through hydrological observations.

The Unit maintains 204 rain gauge stations. Besides the Board of Revenue maintains another 278 rain gauges, whose technical control also vests in the Hydrology Unit. We have not been able to appreciate why the rain gauges should be under the control of two departments, particularly when the Board's gauges are technically controlled by the Hydrology Unit of the Irrigation Department, and we would like the State Government to examine whether all rain gauges should not be put under the Irrigation Department.

The Unit maintains 37 river gauge sites, of which 9 are equipped with current meters, automatic level recorders, silt equipment etc. Of these, 11 gauge sites record hydrological and silt observations all the year round and the remaining 26 only during the monsoon season. The gauge sites are located on the prospective project sites or near the border on inter-State rivers. The State Government proposes to furnish all the gauge stations with the latest equipment.

There are three categories of gauges: long range, short range and temporary. The long range sites are situated on inter-State rivers or on the proposed major storage schemes. Short range and temporary sites are meant for smaller storage schemes and may be discontinued after the projects are taken up.

The Unit also maintains 9 silt laboratories, 10 class IV meteorological observatories and one evaporation control and experimental station.

The Hydrology Unit has not so far published any gauge discharge data. The rainfall data from the year 1957 is likely to be published shortly. Daily rainfall records for the years 1957, 1958 and 1963, 1964 and 1965 have already been published.

17.9 For want of gauge discharge data over a sufficiently long period, it is not possible to assess the surface water resources of the State based on hydrological observations. River gauging started only from the year 1959. An attempt has, however, been made to assess roughly the resources with the help of an empirical formula recommended by W.L. Strange, according to which the average flow of the various rivers is as given in Table 17.3 below. Sub-basin-wise flows are indicated in Appendix 17.1.

Table 17.3

Average Annual flows of Rivers of Rajasthan

Rivers	Average flow in	
	M.cft.	m.cu.m.
1	2	3
Banas	141,177	3,995
Mahi	302,839	8,570
Chambal	153,605	4,347
Sabarmati	24,311	688
Luni	29,398	832
Shekhawati Rivers	9,926	281
Misc. Rivers	63,315	1,792
Total	724,571	20,505

Ground Water Resources

17.10 Systematic ground water surveys for the regional mapping of aquifers and ascertaining the depth and the quality of ground water etc. have not so far been undertaken. Only some short-term local investigations have been carried out. The two organisations in the State which investigate ground water are the Geological Survey of India; and the Rajasthan Ground Water Board.

Rajasthan has been divided into 12 sectors six of which are being studied by the Rajasthan Ground Water Board. Preliminary ground water surveys in the Jodhpur-Nagaur, Jaipur-Sawaimadhopur, Alwar-Bharatpur, Pali and Jalore, Jalore-Sirohi sectors have been completed. A detailed survey of the Nagaur and Jaipur-Sawaimadhopur sectors is in progress. The preliminary ground water survey of the Bhilwara and Chittorgarh districts is also in progress and that of Dungarpur and Banswara districts will be taken up soon. For preparing an assessment report of ground water for the Agriculture Refinance Corporation, a survey of 22 development blocks has been carried out in various districts of the State.

Ground water surveys have also been carried out by the Geological Survey of India, and 173,000 sq. km. in the districts of Churu, Sikar, Ajmer, Bikaner, Nagaur, Tonk, Bhilwara, Jodhpur and parts of Jaisalmer, Barmer, Pali, Jalore, Jaipur, Bharatpur, Alwar, Chittorgarh, Udaipur, Jhunjhunu, and Sawaimadhopur have been covered.

Present Stage of the Development of Irrigation

17.11 Before the construction in the period 1922-1927 of the Gang Canal which was the first major effort in irrigation development in Rajasthan, the sources of irrigation in the State were wells, tanks and rapats.

The Gang Canal takes off from the Sutlej on the left bank of the Ferozepur Barrage just upstream of the head regulator of the Eastern Canal. It was constructed to irrigate lands in the former Princely State of Bikaner. The main canal, which is 135.1 km. in length and which, except for the first 8 km, is lined throughout, with hydraulic lime concrete, was the first large canal in India to be lined. The main canal was constructed by the Punjab Government, while the distribution system was constructed by the Bikaner State Government. The concrete lining was meant to cut down absorption losses in the first 117 km. of the main canal which runs through the Punjab State. In this long reach, no irrigation is done. The culturable command area of the canal is 283, 290 hectares, and the gross area irrigated 225,885 hectares.

Some of the important works costing Rs. one million or above con-

structed in the pre-Independence period in the area now constituting Rajasthan, are listed in the Table 17.4.

Table 17.4

Projects Costing Rs. One Million or More Constructed in Rajasthan in the pre-Independence Period

Sl. No.	Name of Project	Source of irrigation	Benefit in hectares	Cost in Rs. million	Year of construction
1	2	3	4	5	6
1.	Swarup Sagar Pichola-system	Kotra Nadi	440	2.1	1933 canal extended in 1953
2.	Fateh Sagar		320	1.1	Canal extended in 1953
3.	Jai Samand	Gumti & Jamari	4,050	6.0	1910 canal extended in 1953
4.	Bhupal Sagar		1,620	1.1	Canal extended in 1942
5.	Raj Samand	Gumti Nadi	3640	17.4	1861/1950-51
6.	Sardar Samand	Sukri & Guniya Nadi	3580	2.6	1906
7.	Mansarower	Kundli Nadi	1,510	1.5	1951
8.	Galai Sagar	Kalendi	1,170	2.1	1939
9.	Dhill Sagar	Dhill Nadi	3,610	1.4	1939
10.	Ram Garh	Ban Ganga	8,430	2.7	1901
11.	Gang Canal	Sutlej	303,520	33.2	1927
12.	Parvati Pick-up weir	Parvati	7,990	3.1	..

17.12 In the post-Independence period, several works were taken up, the most important of which was the Rajasthan Canal Project, to utilise the surplus waters of the Ravi, Beas and Sutlej. Other major projects are the Bhakra Irrigation Project (Rajasthan portion) and the Chambal Project Stage I and II. Table 17.5 gives a list of projects costing more than Rs. 10 million undertaken since 1951.

Rajasthan Canal Project

The project envisages a canal taking off from the Harike Barrage across the Sutlej. The first 178.3 km. of the canal will lie in Punjab and Haryana and the balance of 506.8 km. in Rajasthan. The capacity at the head will be 523.55 cumecs (18,500 cusecs). The Feeder Canal will run for a length of 178.3 km. in Punjab and Haryana and for 37.7 km. in Rajasthan totalling

Table 17.5

Projects Costing Rs. 10.0 Million or More Constructed in Rajasthan since 1951

Project	Cost (Rs. million)	
1	2	
Rajasthan Canal Project Stage I	1102.0	(excluding share cost of Harike, Madhopur-Beas Link and Pong Dam)
Bhakra irrigation (nearly completed)	234.0	
Chambal Project—Stage I (nearly completed)	323.6	
Jawai (completed)	25.0	
Parwati (completed)	12.2	
Ranapratap Sagar	70.7	
Mahi (Banswara)	30.0	
Gurgaon Canal	30.2	
Khari Feeder	11.8	
Beas Project Unit-II	872.2	
Jakham Part II	30.0	
Sei Diversion	15.0	
Meja Feeder	16.6	

to 216 km. The remaining 469.1 km. will be the main canal. About 0.6 million hectares in Bikaner and Jaisalmer districts will be benefited.

The main canal is being lined to reduce absorption losses and to bring down the per cumec cost. Lining will lead to a saving of water, and, in consequence, to an extension of the command.

About 77 km. of both the Rajasthan Feeder and the main canal have been completed along with their distributaries, and about 97,128 hectares of the command were receiving irrigation by March 1969.

Bhakra Irrigation

The project which is nearing completion is a joint venture of the Punjab, Haryana and Rajasthan States. Rajasthan is entitled to 15.22 per cent of the total stored supplies of the Bhakara Dam. Punjab is responsible for the construction of all the common works and the distribution system which aggregates 1,467 km. About 0.23 million hectares in Ganganagar district will be benefited by the project.

Chambal Project—Stage I

Taken up in 1954 this project was completed in 1967. It comprises (i) the Gandhi Sagar dam across the Chambal (ii) a power station at the

Gandhi Sagar dam to accommodate ultimately five power units each of 22,000 KW (iii) a H.T. transmission line of a total length of 730 km and (iv) a barrage across the Chambal above Kota city with canals taking off on either side. A part of the canal system, is functioning. On full development, the project is likely to benefit 0.22 million hectares in the districts of Kota and Bundi.

Chambal Project—Stage II

The Rana Pratap Sagar Dam and the Power House form Stage II of the Chambal Project. The masonry dam will be 56 km. downstream of the Gandhi Sagar Dam. It will have a length of 1,143 m. and a height of 54 m. above the deepest foundation. The power house located below the dam will have an installed capacity of 172,000 KW. The sagar will create an irrigation potential of 0.12 million hectares, to be shared equally by Rajasthan and Madhya Pradesh. Taken up in 1961 the project is nearing completion.

Beas Project

The Beas Project is an inter-State multipurpose scheme to harness the irrigation and power potential of the Beas. There are two main units:-

Unit No. I —The Beas Sutlej Link & Right Bank Power Station at Dehar;

Unit No. II — The Beas Dam at Pong and the Pong Power Station.

On completion, the project will make available a perennial supply of water to the Rajasthan Canal for irrigating an area of 1.16 million hectares annually. In addition, Rajasthan will get about 150 MW of firm power. The Beas Dam is an earth core-cum-gravel dam with a length of 1951 m, and a height of 116m. Taken up in 1961 the project is likely to be completed in 1974.

Jawai Dam Project

A masonry dam, 871 m. long and 34 m. high across the river Jawai, was the first important irrigation work to be completed (1959) by the Rajasthan State during the First and Second Five year Plans. With a network of 211 km. of main canals and branches, the project has benefited 7,690 hectares in the Pali district.

Mahi (Banswara)

The scheme envisages a 57.3 m. high, 2,987 m. long gravity dam partly of masonry (518 m.) and partly of earth (2,469 m.) across the river Mahi

near Borkhera village about 16 km. north-east of the Banswara. The Right and Left Main canals, 90 km. and 45 km. long respectively will irrigate an area of 30,757 hectares lying mostly in Banswara district.

Gurgaon Canal

The scheme contemplates the utilisation of 14.15 cumecs (500 cusecs) of Yamuna water in Bharatpur district. Haryana will deliver water to Rajasthan at the Haryana Border. The Gurgaon Canal will be constructed at a point on the Agra Canal 8 km. below the Okhla weir near Delhi. The scheme is likely to benefit an area of 25,091 hectares in the Bharatpur district.

Jakham Part II

The project provides for the construction of a masonry dam 62 m. high across the Jakham near the village of Heldukhera in Udaipur district, with a pick-up weir 11.3 m. downstream and two canals of an aggregate length of 148 km. taking off from the weir. About 11,520 hectares in Udaipur district will be benefited. A pick-up weir and a short channel on the left bank 22.5 km. long will be constructed in the first stage of the main scheme.

Wells and Tubewells

Irrigation by open dug wells has always been the main source of irrigation in Rajasthan. In 1961-62, there were 0.45 million wells in use for irrigating lands. This figure rose to 0.61 million by the 30th June 1968. The area irrigated from wells and tubewells has risen to 1.02 million hectares in 1965-66.

Region-wise the total number of tubewells working at the end of each plan period and as on 30.6. 1968 are given in Table 17.6.

Table 17.6

Tubewells working in different regions as on 30.6.1968

Region	No. of tubewells working at the end of			
	1st Plan	2nd Plan	3rd Plan	30.6.68
1	2	3	4	5
Western Rajasthan	80	183	476	1,210
Eastern Rajasthan	230	989	2,704	4,661
Total State	310	1,172	3,180	5,871

The areas irrigated from different sources in 1965-66 are shown in Table 17.7.

Table 17.7

Source-wise Irrigation in Rajasthan—1965-66

Source	Area irrigated in thousand hectares
1	2
Government Canals	701
Private Canals	—
Tanks	219
Tubewells	12
Wells	1,176
Other sources	19
Total	2,119

The salient features of irrigation works irrigating over 4,000 hectares each, are given in Appendix 17.2.

Soil Conservation

17.13 The programme of soil and moisture conservation was started in the State in the year 1957-58 with the aim of controlling wind and soil erosion on agricultural land, particularly in dry-farming areas.

The following works have been carried out in the catchments of the Gandhi Sagar, Ranapratap Sagar and Kota dams, and of the Kota Barrage under the scheme of Soil Conservation in River Valley Projects.

I. *Forestry Sector*

(i) Creation of grazing paddocks	30,070 hectares
(ii) Clearance and maintenance of firelines	608 km.
(iii) Afforestation:	
(a) Stream Bank	360 hectares
(b) Marginal lands	536 hectares
(iv) Engineering works outside the paddocks	6 Nos.

II. *Agriculture Sector*

(i) Survey of fields	3,252 hectares
(ii) Soil conservation measures	1,967 hectares

Details of the work done in afforestation, pasture development, sand-dune fixation and creation of shelter belts, plantations along roads etc. are shown below:

(i) Afforestation and pasture development works	8,967 hectares
(ii) Fixation of sand dunes	7,776 hectares
(iii) Shelter belts, plantation along roads	143 km.

The progress of soil conservation works in Rajasthan from 1957 to June 1969 is as shown below:

(i) Work on agricultural catchments	246,785 hectares
(ii) Land levelling	5,800 hectares
(iii) Irrigation layouts	3,215 hectares
(iv) Pasture development	32,951 hectares
(v) Reclamation of saline and alkaline soils	1,067 hectares

During the Fourth Five year Plan the proposed targets against an estimated expenditure of Rs 10 million on the Chambal Project are as shown below:

(i) Creation of grazing paddocks	15,600 hectares
(ii) Afforestation	1,000 hectares
(iii) Creation of new roads	260 km.
(iv) Soil conservation measures on agricultural lands	11,500 hectares
(v) Terracing on agricultural lands	270 hectares

An allocation of Rs. 10 million has been proposed for a similar programme on the Dantiwada Project during the Fourth Five Year Plan. The catchment area to be covered measures 1,903.63 sq. km. The creation of rotational grazing paddocks, raising of plantations in marginal lands, undertaking fire protection measures in forest areas, and soil conservation measures on agricultural fields etc. are envisaged.

In the Fourth Plan a sum of Rs. 2.7 million has been provided for soil conservation over an area of 4,500 hectares in the hills, and for a survey to be done by the Forest Department over 85,000 hectares in the ravine areas.

After the introduction of irrigation, the levelling of land, which is gently undulating or uneven, is done by the cultivators themselves.

In the Chambal Project, marginal lands along the river banks are highly ravined, and land-levelling is extremely expensive. In the Rajasthan canal area the main problems in ayacut development are the denudation of the soil, the undulating topography and, at some places, abnormally large sand dunes.

Drought Affected Areas

17.14 Rajasthan is the driest State in India. The annual rainfall varies from 90 cm. in the Chambal basin to 13 cm. in the Thar desert. There are 11 districts namely—Jaisalmer, Bikaner, Ganganagar, Barmer, Jodhpur,

Nagaur, Churu, Pali, Jalore, Sikar and Jhunjhunu which fall in the arid and semi-arid zone and cover 61.40 per cent of the area of the State and 36.33 per cent of its population. In the remaining areas the rainfall ranges from 25 cm. to 50 cm., and is highly variable and erratic. Crop failures are not infrequent. In the desert regions every second year is a drought year. Soil conditions in these areas have been deteriorating because of erosion by wind and through over-grazing. The absence of perennial rivers and the low ground—water table accounts for the dearth of minor irrigation works.

According to the State Government, the probability of drought in Rajasthan is once in 2.5 years.

The State has classified the following tehsils as being chronically drought affected areas.

Other tehsils in the districts referred to above, though not classified as chronically drought affected, are frequently affected by drought.

Table 17.9 gives the expenditure incurred on famine works and the number of villages affected from 1963-64 to 1967-68 in the State.

Table 17.8

Chronically Drought Affected Areas of Rajasthan

Area/District	Tehsils
1	2
I. Western Desert	
1. Jaisalmer	i) Jaisalmer
	ii) Pokaran
2. Barmer	i) Barmer
	ii) Shiv
	iii) Pachpadra
3. Jodhpur	i) Phalodi
4. Churu	i) Dungargarh
5. Bikaner	i) Bikaner
	ii) Lunkaransar
	iii) Kolayet
II. Hilly Areas	
6. Ajmer	i) Ajmer
	ii) Beawar
7. Udaipur	i) Kherwara
8. Dungarpur	i) Aspur
	ii) Dungarpur
	iii) Sagwara
9. Banswara	i) Garhi
	ii) Ghatol
	iii) Bagidora

Table 17.9

Famine Relief Works in Rajasthan

Year	No. of villages affected	Population (million)	Expenditure on famine works (Rs. million)
1	2	3	4
1963-64	6,422	4.89	15.6
1964-65	8,715	1.28	45.9
1965-66	10,888	5.55	13.2
1966-67	9,715	4.51	121.3
1967-68	2,365	1.53	78.1

It is beyond argument that the direct expenditure on famine works plus the suspension and remission of land tax and other dues in the drought affected areas is a recurring and heavy burden on the State exchequer. More painful than this burden is the precarious and low standard of living of the people of this area. In some places even drinking water is not available and we are of the opinion that drinking water should be made available without considerations of cost.

Some highly arid areas may not be able to build up an agricultural economy vigorous enough to sustain a reasonable standard of living. Such areas, as suggested by the experts of the Indian Agricultural Research Institute, will have to be a assigned to sheep and cattle breeding.

However, it remains a fact that the real solution of the drought affected areas lies in the extension of irrigation. Among the tehsils or parts of tehsils identified as drought affected those likely to benefit from new irrigation works are shown in Appendix 17.3. The State Government has a programme for the construction of 600 tubewells in the Fourth Plan for which an outlay of Rs. 100 million has been proposed.

It is possible that as a result of further investigations by the GSI and the State agency additional areas may be found to possess groundwater resources suitable for drinking and irrigation.

Future Development of Irrigation

17.15 The State Government has three new schemes under consideration: (Table 17.10).

In addition, the State Government has also investigated four major projects whose particulars are given in Table 17.11.

Table 17.10

New Projects Proposed in Rajasthan

Project	Total estimated cost (Rs. million)	Area proposed to be irrigated (hectares)
1	2	3
Increasing irrigation potential on the Gang Canal System	26.0	101,000
Increasing irrigation potential on the Bhakra Canals	30.0	125,000
Creating potential for rice cultivation on the Bhakra Ganals	3.0	8,100

Table 17.11

Major Projects Investigated

Project	Total estimated cost (Rs. million)	Area proposed to be irrigated annually (hectares)
1	2	3
Baneshwar Hydel Project	350.0	202,343
Bisalpur Irrigation-cum-Water Supply Project	135.0	26,980
Sidhmukh Project	16.5	75,000
Nohar Project	70.9	54,720

In addition to the four major projects investigated, 30 medium and 125 minor schemes have also been investigated so far, in various districts.

There is also scope for the improvement of existing irrigation works, the lining of canals and the extension of irrigation, to improve water management to suit new cropping patterns.

The future potential of irrigation development in Rajasthan from all sources comes to 2.07 million hectares, which will develop the total irrigation in the State to 4.64 million hectares. This works out to about 32 per cent of the gross cropped area.

Table 17.12 indicates, in brief, the ultimate picture of irrigation development in Rajasthan.

Table 17.12

Ultimate Irrigation Development

(million hectares)

Item	Major & medium projects	Minor irrigation works	Total
1	2	3	4
Area irrigated in 1969	0.84	1.70	2.54
Additional area that will be brought under irrigation on completion of projects under execution	1.13	0.3	1.43
New projects	0.67	N.A.	0.67
Total	2.64	2.0	4.64

Source: i) Area irrigated and areas under crops—Statewise 1968-69 (Provisional) —Directorate of E & S, Ministry of Agriculture.
ii) Reports of the Working Group on Irrigation and Flood Control—Fourth Five Year Plan 1969-74.
iii) Indian Agriculture in Brief—Eleventh Edition—Directorate of Economics & Statistics, Ministry of Agriculture.
iv) Replies of the Rajasthan Government to Irrigation Commission's Questionnaire.
v) Report of the Working Group for formulation of Fourth Plan Proposals on Minor Irrigation and Rural Electrification—Ministry of Food & Agriculture.

Floods, Waterlogging and Drainage

17.16 In Rajasthan, flood damage is confined mainly to the two districts of Ganganagar and Bharatpur. In Ganganagar district, flood damage has occurred periodically since 1956 owing to an increase in the intensity and duration of the flow in the Ghaggar river which had, till then, been the flash-flood carrier of the run-off from catchment areas in Punjab and Haryana.

The year-wise figures of irrigated areas within the Bhakra, Bikaner and Rajasthan Canal commands in Rajasthan which were flooded by the Ghaggar are shown below:-

Year	Area flooded (hectares)
1964	54,750
1965	34,500
1966	48,600
1967	32,400
1968	39,700

A flood control scheme has been completed at a cost of about Rs 40 million under which a diversion channel 51 km. long with a designed discharge of 339.6 cumecs (12,000 cusecs) has been constructed to divert the flood waters into depressions in the sand dunes south of the irrigated belt. The total capacity of these depressions is about 950 m.cu.m. (0.77 MAF) which is about equal to the normal monsoon run-off carried by the river at present. If the flood discharge at any time exceeds 339.6 cumecs (12,000 cusecs) and the total run-off in a season exceeds the capacity of the depressions, the water will have to be released into the Ghaggar bed. Such releases are likely to be infrequent. The water so released would saturate the bed and facilitate the raising of a rabi crop after the bed dries up. The Ghaggar diversion channel, although it does not ensure complete protection to the plains against monsoon flooding, does protect them against winter floods of shorter duration and less severity.

The Bharatpur district is largely flat with sizable saucer shaped depression. The slope towards the Yamuna is insufficient to permit adequate drainage of flood water brought down by the Gambhir, and the Banganga from the adjoining areas of Gurgaon district. For the greater part of the year, the water stagnates in low-lying areas and causes damage to kharif crops, inhibits the sowing of rabi crops, and disrupts lines of communication. For the protection of the area, anti-flood measures like the construction of new drains and protection bunds and the desilting and widening of existing drains are being taken up. Improvements in the discharge capacity of the Kaman Pahari Drain which outfalls into the Yamuna through the Goverdhan Drain in Uttar Pradesh and the construction of the Bharatpur City Drain works are important works.

The State Government is envisaging the construction of a dam to protect the areas adjacent to the Dhassa bund against floods. It is known as, the Sabi irrigation-cum-flood control scheme and is likely to cost Rs. 24 million.

17.17 The problem of waterlogging exists in the Chambal command. The water levels in open wells are being regularly recorded twice a year since 1963 in June and October. Based on these observations areas where the water table has risen to between 0 and 1.5 m and 0 and 3 m have been identified as on page 353,

It is clear that the water table under a sizable area has shown a tendency to rise.

In order to tackle this problem some pilot drainage works, namely (i) Ballop (ii) Bham Waria (iii) Mathunda (iv) Raipura (v) Isher Nagar (vi) Soorsagar (vii) Dhanatri (viii) Kalatalao (ix) Khatelar and (x) Sitapura schemes have been completed at a cost of about Rs. 3.1 million to protect an area of 8,728 hectares. About 219 km. of surface drains have been

Month/year of observation	Depth of water	Waterlogged area in L.M.C.	R.M.C.	hectares Total
1	2	3	4	5
Oct. 1963	0 to 1.5 m	21,900	7,750	29,650
	0 to 3 m	88,500	76,200	164,700
Oct. 1968	0 to 1.5 m	47,200	48,500	95,700
	0 to 3 m	184,300	163,800	347,600

constructed for this area. The results have been encouraging and the areas reclaimed through these schemes has varied in extent from 60 to 100 per cent. Additional schemes to treat a further 6,600 hectares at a cost of Rs. 1.8 million have also been taken up for execution.

The surface drains constructed so far have proved their utility and it is now proposed to improve the drainage in the entire Chambal command according to a phased programme. Under the United Nations Development Programme, studies are being conducted to explore the possibilities of lowering the water table with the help of tubewells.

No specific investigations have so far been made to assess the effect of irrigation on the extent and magnitude of salinity in canal commands. In the Chambal command, a soil survey was carried out in the years 1951-55, according to which about 40,000 hectares which had been under irrigation for about 9 years were declared as saline and alkaline.

It has now been established that shallow drains are very necessary to wash out the accumulated salts on the surface. Land and water resources problems including those of salinity are being dealt with by the experts of the Food & Agriculture Organisation under the United Nations Development Programme, Chambal Project launched in 1967.

Water Rates

17.18 The details of the water-rate structure for irrigation supplies from gravity canals and tanks are given in Schedule I of the Rajasthan Irrigation and Drainage Rules, 1955.

From December 22, 1958, the water rates being charged in some of the important projects are given in Appendix 17.3.

From this, it will be observed that there are too many different water rates and they are not based on any uniform principle. Perhaps this situation is inherent in the conditions of a State which was formed by the merger of several autonomous units. In Chapter XI of the first volume of the

Report, we have enunciated some general principles for fixing water rates. We are of the opinion that there is urgent necessity for revising water rates for all types of works, major, medium and minor, in Rajasthan to introduce a degree of rationality. In fixing water rates on inter-State rivers, the rates charged in other States will have to be borne in mind.

Irrigation by tubewells and lift schemes has made a start in the State during the last few years and water charges are levied more or less on a no-profit no-loss basis. On certain tubewells maintained and operated by the Rajasthan Ground Water Board the prevailing rates vary from Rs. 6.14 to Rs. 6.25 per acre inch of water.

Betterment Levy

17.19 Details of the betterment levy collected so far are given below:

Project	Basis of evaluating betterment levy	Mode of payment	Date from which collected	Amount collected up to March 1969 (Rs. million)
1	2	3	4	5
Bhakra	on the basis of 1/3rd of the Net Assets	24 equal instalments	1959-60	13.67
Chambal	(X-Y) (15Z)	10 instalments	1965-66	0.17
13 medium & 14 minor projects in the State	(X-Y) (15Z)	10 instalments	1964-65 to 1968-69 (in different cases)	0.51

In the Formulae (X-Y) (15Z)

"X" represents the average of the wet rent rates of the CCA of the project.

"Y" represents the average of the dry rent rates of the CCA (both cultivated and uncultivated under the project)

"Z" represents the intensity of irrigation in the project.

Some of the important decisions taken by the Government in this respect in 1963 are given below:

(i) Notice for the realization of betterment levy will issue in respect of lands actually receiving irrigation after the commencement of the scheme. Lands not receiving irrigation, even though included in the command, may not be charged betterment levy.

(ii) Lands which have not received irrigation at all will not be charged betterment levy till they have actually received irrigation.

(iii) Lands declared as 'Chahi' in the settlement records will not be charged any betterment levy.

(iv) Lands that have suffered damage on account of waterlogging and which could not be improved by suitable measures will not be assessed to betterment levy.

(v) The demand slips for the realization of betterment levy at the assessed rate will be issued only for lands which have received irrigation for a period of five years from the project and the average area of the later three years shall be reckoned for working out the demand. However, when the development of the land has been delayed during the first five years and has developed in the 6th, 7th and 8th year, the average area of the subsequent three years shall be taken for charging the betterment levy.

Tours, Observations and Impressions

17.20 We toured the Chambal Project in Rajasthan on October 28th and 29th, 1971, visiting Ranapratap Sagar dam, the Atomic Power Station, the Kota barrage and portions of the left and right main canals and the UNDP Research stations at Nanta and Digod in district Kota.

We were able to have discussions with the Chief Engineer and other officers of the Irrigation and Agriculture Departments and the UNDP Project officers at Kota on October 29th.

During our tour we were accompanied by the Chief Engineer, Irrigation Department, who acquainted us with the problems of the Chambal right bank canal and the measures which have been adopted to overcome them.

17.21 The total live storage capacity of the two reservoirs, Gandhi Sagar, the uppermost (6,920 m.cu.m.) and Ranapratap Sagar the lower one (1,567 m.cu.m.) is 8,622 m.cu.m. The lowest—Jawahar Sagar has a nominal capacity of 5 m.cu.m. To run both the canals so as to meet the water requirement of crops adequately, requires a pondage capacity of 6,574 m.cu.m. If the inflow in the river is adequate to fill up the reservoirs every year the canal requirements can be met without difficulty. However, as it is, the annual average yield of the river is only about 3,700 m.cu.m. and this imposes a limitation on the running of the canals. With the completion of the atomic power station at Gandhi Sagar, the water releases from the reservoirs for hydel power generation can now perhaps be limited for peaking purposes and the first demand on releases of water can be for irrigation. This may benefit the development of irrigation to some extent. The State may look into this matter.

17.22 A small 36 cumecs left bank canal from the Kota barrage irrigates areas in Rajasthan State. The right bank canal, with its head discharge of 188 cumecs, is a common carrier between Rajasthan and Madhya Pradesh in its first 130 km. It was opened for irrigation in 1960 when the barrage was inaugurated. The share of Rajasthan and Madhya Pradesh is 78 cumecs and 110 cumecs respectively. Even after a decade of operation the canal has not developed its full potential and is at present irrigating a gross area of only 0.15 million hectares (0.08 million hectares in Rajasthan and 0.07 in Madhya Pradesh) against the total proposed 0.46 million hectares (0.17 in Rajasthan and 0.29 in Madhya Pradesh).

The main reasons indicated to us were:

(i) Weed growth in the canal which grossly curtails its carrying capacity;

(ii) Ayacut development not keeping pace with the creation of water potential.

We understand that the Government of India appointed a Technical Committee to look into the difficulties which hinder the canal from being run with its full supply discharge. The measures recommended by the Committee to control the weed growth and improve the structural features of the canal have already been partially implemented and the canal is now capable of running with a sustained discharge of about 170 cumecs.

We were informed that the total expenditure involved in implementing all the recommendations of the Committee would be about Rs. 15 million. When all the improvements are carried out it is expected that difficulties in running the canal with the full supply discharge all the year round would be overcome.

Ayacut Development

17.23 No ayacut development programmes were prepared initially, with the result that even after 10 years of the opening of the canal, field channels and field drains have not been excavated, and field to field irrigation is generally practised. Besides, no substantial progress has been made in land shaping and land levelling, consolidation of holdings, development of ayacut roads and other elements of the infrastructure.

The proposed intensity of irrigation in Rajasthan is 21 per cent in kharif and 55 per cent in rabi. Whereas rabi has developed to 56 per cent, the kharif irrigation is limited to only 9 per cent. Farmers are not keen on kharif irrigation as the average rainfall in the ayacut is about 81 cm. and they are content to sow traditional varieties. They also appear reluctant to take water for fear of waterlogging and the development of salinity which has already damaged certain areas.

It also appears that farmers do not do irrigation during the night. This not

only results in a waste of water but also leads to waterlogging. As the demand for water is now steadily increasing, it is necessary to enforce night irrigation through a system of warabandis for the distribution of water between co-sharers on a canal outlet. We were told that the State Government are already thinking of introducing the warabandi system to ensure a better utilisation of water. With an ayacut development Commissioner now in position, irrigation should develop properly and systematically. With more demonstrations the farmers would realise the benefits of canal irrigation for raising high-yielding paddy, and by lessening their dependence on rainfall.

During our visits we were able to see the UNDP Project on two farms located at Nanta and Digod. They are experimenting with different methods of lining canal minors and field channels and with biological methods of controlling weeds.

We were heartened to see the work that has been taken up in the farmers' fields at Digod village in the ayacut of the Right Bank Canal. The aim is to convert the fields into compact strips with light slopes of 0.05 per cent to permit the slow percolation of water and to lay out proper irrigation and drainage channels so that each field may be served individually. The cost would work out to about Rs. 3,950 per hectare. It is proposed to be recovered from the farmers in 7 annual instalments. The few farmers to whom we talked appeared enthusiastic about this work. In order, however, to persuade the farmers to take advantage of the scheme, some legislation may be necessary. Through this process there is bound to be an acceleration in development of irrigation. We were told that the State Government have already prepared a scheme for the reclamation of 18,210 hectares by seeking financial assistance from the Agricultural Finance Corporation.

Waterlogging

17.24 The Chambal canal runs between heavy embankment in long reaches which results in heavy seepage. These conditions have been accentuated by the continuous excavation of deep burrow pits in the canal bed and the removal of the impervious top layer of soil to expose the porous lower layers.

We were glad to learn that the State is aware of this problem and are taking adequate measures to remove drainage congestion, by connecting cross-drainage works to natural streams and by constructing surface drains in the ayacut. With intensive effort the menace of waterlogging is likely to be overcome in due course. In the meantime, however, it is important that systematic observations of the ground water table should be carried out in the hot weather and in the post-monsoon period to guide future efforts in this direction.

Ground Water

17.25 The project area is not very rich in ground water. The conjunctive use of ground and surface water for the control of the ground water table and for supplementation of surface water has, therefore, few possibilities. The only way to use ground water appears to be through shallow tubewells or dugwells.

Soil Conservation

17.26 We were glad to see the activities in soil conservation in the Chambal catchment area. The Forest Department of Rajasthan, as part of its soil conservation work, has commenced to enclose degraded pasture lands from 1961 onwards. So far about 414 sq.km. have been so treated. There is a good growth of grass in the enclosed areas which is bound to reduce the sediment load of the river. We would recommend the extension of the practice to other selected areas in the catchment which may be considered as contributing a heavy silt load.

Miscellaneous

17.27 Benefits from the right bank canal are shared by Rajasthan and Madhya Pradesh. The entire maintenance of the common carrier in the first 130 km is, however, in the hands of Rajasthan. This gives rise to disagreements and continued argument not only on technical matters but also with regard to the sharing of benefits and costs. A suitable organisation in which both parties are represented, should be useful and would eliminate many difficulties.

CHAPTER XVIII

TAMIL NADU

In 1953, the Telugu-speaking districts of the erstwhile State of Madras, and portions of Bellary district which had a predominantly Kannada-speaking population, were detached from the State of Madras. The Telugu-speaking districts were formed into Andhra Pradesh and the Kannada speaking portion of Bellary was attached to Mysore. Again in 1956, during the re-organisation of the States, South Kanara which was Kannada-speaking, and Malabar which was Malayalam-speaking, were transferred to Mysore and Kerala respectively, and the Tamil-speaking areas of Kanniyakumari district were added to the State of Madras which in December 1968, was renamed as Tamil Nadu, or the "land of the Tamil-speaking people".

The reconstituted State has a geographical area of 130,070 sq. km, and is the southern-most State of the Union. It is bounded on the east by the Bay of Bengal, on the south by the Indian Ocean, on the west by the State of Kerala, on the north-west by the State of Mysore, and on the north by the State of Andhra Pradesh.

According to the 1971 census, the population of Tamil Nadu was 41.10 millions. Its density of population was 316 persons per sq. km against the all-India average of 182. About 70 per cent of the population lives in the rural areas.

In Tamil Nadu, as in most States of the Union, agriculture is the predominant occupation, employing more than 60 per cent of the people. As much as 47.5 per cent of the cultivated area in the State is irrigated, which makes it the best irrigated State in the country, next to Punjab. Irrigation has an ancient history in this State, and in the Cauvery Delta the Grand Anicut was originally built by the chola kings.

Rice is the most important crop of the State. In 1970-71, its production was 5.3 million tonnes, representing one-eighth of the country's production of rice. The area under rice is 2.69 million hectares which works out to 7.2 per cent of the total area of this crop in the country. Other important crops grown in the State are jowar, small millets, groundnut, sugarcane and cotton.

At the beginning of the First Five Year Plan, 852 thousand hectares were commanded by major and medium irrigation schemes, and 925 thousand hectares were under the command of minor schemes. Since then, there has been considerable development, and by 1967-68, the net area irrigated from all sources increased to 2.6 million hectares. However, in the following year, there was a slight set-back owing to unfavourable climatic conditions and only 2.4 million hectares of net cropped area was irrigated that year.

Physical Features

18.2 The State falls into four main physiographic regions:-

(i) The Coastal Plains
(ii) The Eastern Ghats
(iii) The Central Plateau, and
(iv) The Western Ghats

The coastal plain stretches for nearly 1,000 km from the Pulicat lake to Cape Comorin. The northern part of this plain 80 to 100 km wide, spreads over Chingleput district, most of South Arcot district, the eastern part of North Arcot district and the northern part of the Tiruchchirapalli district. The middle plain comprises the delta of the Cauvery and consists of Thanjavur district, and part of Tiruchchirapalli. The southern plain extends to the Ramanathapuram, Tirunelveli and Kanniyakumari districts. The soil over the whole area is rich alluvium.

To the west of the coastal plains lie the Eastern Ghats which are connected by spurs to the Nagari hills and to the Varushanad, Andipatti, and Cardamom ranges. The Ghats in this area vary in height from 1,100 m. to 1,650 m.

Between the Eastern and Western Ghats, lies the Central Plateau ranging in elevation from 610 m. to 1,525 m. From the Palaghat Pass between the Nilgiris and the Anamalai hills to the Cauvery, extends a low plateau intersected by the Bhavani, the Noyyil and the Amaravathi rivers which rise in the Ghats. The Plateau has an elevation ranging from 120 m. to 460 m.

To the west of the Central Plateau are the Western Ghats which, for a long distance, form the boundary between Tamil Nadu and Kerala. Some of the highest peaks in the Nilgiris and the Anamalais lie in this region. It is in the Western Ghats that the Cauvery, the most important and the most exploited river of Tamil Nadu, rises.

Soils

18.3 The soils of the State fall into four groups:-

(i) Red and laterite soils

(ii) Black soils
(iii) Alluvial soils
(iv) Forest and hill soils.

Red and laterite soils are found in almost every district of the State. Their greatest concentration lie in the districts of Madurai, North Arcot, Chingleput, Salem, Coimbatore, Tirunelveli and Tiruchchirapalli. Only in Thanjavur and Ramanathapuram districts are these soils not predominant. Though red soils are generally less fertile than black soils, poor in nitrogen and in organic matter, their loamy structure, and the intermixture of thin and fine textured soils make them more versatile than the black soils.

Black soils are found all over the State, with the largest concentrations in Ramnathapuram, South Arcot, Tiruchchirapalli and Thanjavur districts. They cover less than 25 per cent of the area of the State. They are fertile, but poor in organic matter, nitrogen and phosphoric acid.

The concentrations of alluvial soils are found, as could be expected, in the Cauvery delta which consists of the district of Thanjavur, and along the banks of the river in Tiruchchirapalli district. The Cauvery alluvium is rich, and well-supplied with potash and magnesium, although it is poor in nitrogen.

Forest and hill soils predominate in the Nilgiri hills and in the Kanniyakumari district. They are porous in texture and rich in organic matter, nitrogen and other nutrients.

Climate and Rainfall

18.4 Because of its tropical climate, the maximum temperature seldom rises above 44°C or falls below 18°C.

Although both the south-west and north-east monsoons bring rain to Tamil Nadu, its incidence is most irregular. Three quarters of the State's territory lies in the rain-shadow of the Western Ghats, and precipitation in these semi-arid areas is only 50 cm to 100 cm. More fortunate districts such as Thanjavur, South Arcot, Chingleput and North Arcot, get fairly well distributed rain from both monsoons. The total rainfall there is higher than in other districts, excluding the Nilgiris and Kanniyakumari which receive an average rainfall varying from 145 to 190 cm. The districts which get less than average rainfall in the State are Tirunelveli, Coimbatore, Tiruchchirapalli and Ramanathapuram, and this rain is received only in the north-east monsoon period. During the hot months from March to June, occasional thunder showers bring rain to most districts, but this rain is small in quantity and irregular in incidence.

Land Use and Cropping Pattern

18.5 Table 18.1 gives the land utilisation statistics of the State in 1968-69.

Table 18.1

Land Use Details—Tamil Nadu

Classification	Area (Thousand hectares)	Percentage of reporting area
1	2	3
Reporting area	13,011	
Forests	1,925	14.8
Land not available for cultivation	2,258	17.3
Other uncultivated land excluding fallow land	1,222	9.4
Fallow land	1,715	13.2
Net area sown	5,891	—
Total cropped area	6,914	—
Area sown more than once	1,023	—
Net irrigated area	2,417	—
Gross irrigated area	3,092	—
Percentage of net irrigated area to net cultivated area		41.0
Percentage of gross irrigated area to gross cultivated area		44.7

Source: E & S Directorate, Ministry of Agriculture, Government of India, New Delhi.

It is clear that about 45 per cent of the area of the State is under crops (very near the average for the country as a whole). If we exclude the 32 per cent under forests or otherwise not available for cultivation, only 23 per cent of the land remains to be brought under the plough. However, bearing in mind that a portion of land must always lie fallow, and that some land must be retained to serve as pasture land, it is clear that the area available for the extension of cultivation is limited. The alternative method for increasing agricultural production would be through multiple cropping and increasing per-hectare yield of crops. Double cropping is done over 17 per cent of the area. During our visit to the State, we were told that one reason why more land, particularly in the Cauvery Delta, is not being double cropped, is the shortage of labour. Because rice cultivation requires the extensive use of labour, this imposes limits on the extent of double cropped paddy land, even if double cropping is otherwise feasible.

Foodgrain crops are grown on 68 per cent of the gross cultivated area, with rice as the main crop, accounting for 34.2 per cent. Minor cereals such as jowar, ragi, bajra etc. account for a further 27.6 per cent. Pulses add another 6.3 per cent. Among non-food crops, groundnut accounts for 13.5 per cent of the total area under all crops, cotton for 4 per cent and cash crops like coffee and tea account for 1 per cent. Table 18.2 shows the position in 1968-69.

Table 18.2

Principal Crops Grown in Tamil Nadu

Crop	Area (Thousand hectares)	Percentage to total cropped area
1	2	3
Rice	2,363	34.2
Jowar	700	10.1
Ragi	301	4.4
Bajra	457	6.6
Other cereals and millets	449	6.5
Total cereals and millets	4,270	61.8
Pulses	439	6.3
Total foodgrains	4,709	68.1
Sugarcane and others	193	2.8
Condiments & spices	98	1.4
Fruits, vegetables and other food crops	252	3.7
Total food crops	5,252	76.0
Groundnut	931	13.5
Other oilseeds	194	2.7
Cotton	276	4.0
Total non-food crops	1,662	24.0
Total cropped area	6,914	100.0

Source: E & S Directorate, Ministry of Agriculture, Government of India, New Delhi.

Agricultural Production

18.6 Generally, though not solely, because of the extensive irrigation, the yield per hectare of the major crops, with the exception of pulses, is much higher than the average of the country. This is illustrated in Table 18.3.

Table 18.3

Yields of Principal Crops—Tamil Nadu

Crop	Yield in Kg. per hectare in 1970-71	
	Tamil Nadu	All India average
1	2	3
Rice	1,974	1,134
Jowar	732	534
Pulses	236	516
Oilseeds	849	599

Source: E & S Directorate, Ministry of Agriculture, Government of India, New Delhi.

There has also been a steady increase over the years from 1950-51, in the total agricultural production. The table below bears this out.

Table 18.4

Production of Important Crops

(Thousand tonnes)

Crop	Production at the end of				
	1950-51 (Pre-Plan)	1955-56 (1st Plan)	1960-61 (2nd Plan)	1965-66 (3rd Plan)	1970-71
1	2	3	4	5	6
Rice	1,712	3,012	3,559	3,709	5,303
Jowar	351	486	547	501	547
Pulses	72	104	112	94	110
Total food-grains	2,933	4,611	5,294	5,251	7,024
Oilseeds*	802	884	1,104	928	959

*Include groundnut, sesamum, rape and mustard, castor and linseed.
Source: Directorate of E & S, Ministry of Agriculture.

Table 18.4 brings out clearly that there has been a continuous increase in production from 1950-51 to 1970-71, except in the drought year 1965-66.

In absolute terms, foodgrain production has risen from 2,933 thousand tonnes in 1950-51 to 4,611 in 1955-56 and to 5,294 in 1960-61 by the end of the Second Plan—an overall increase of 80 per cent. During the same period, however, the area under foodgrains rose by only 16 per cent, from 4.41 million hectares to 5.10 million hectares.

During the Fourth Plan, the State Government is concentrating on increasing food production by the widespread use of high-yielding varieties of paddy and other food crops. In 1969, as many as 0.8 million hectares were brought under high-yielding paddy strains, and about 70,000 hectares under other high-yielding cereals. Where there is assured irrigation, the area under multiple cropping is also increasing. In Thanjavur for example, 85,000 hectares was double cropped in 1967-68. The State Government anticipates a production of 7.6 million tonnes of foodgrains by the end of the Fourth Plan.

Water Resources

18.7 The river Cauvery is by far the most important river of Tamil Nadu. Other important rivers are the Palar, the Ponnaiyar and the Vellar, which flow to the north of the Cauvery, and the Vaigai and the Tambraparni which flow to the south of it.

The Cauvery rises in the Brahmagiri range of the Western Ghats in Mysore State. Draining an area of 36,240 sq. km and traversing a length of 320 km in that State, the river enters Tamil Nadu. During its passage through Mysore, the Cauvery is joined by the Hemavati, Lokapavani, Shimsha, Lakshmanatirtha, Kabbani and Suvarnavati. In Tamil Nadu, the river drains an area of 48,770 sq. km through its passage of 416 km in the State into the Bay of Bengal. Within the State, its tributaries are the Bhavani, the Noyil and the Amaravathi.

With 90-95 per cent of its waters harnessed for irrigation, the Cauvery is one of the best regulated and fullest exploited rivers in India. Its delta in the district of Thanjavur is called the "rice bowl" of the State. Of the many structures in the river, the best known, as well as the most ancient, is the Grand Anicut which we have referred to earlier in this Chapter. The Mettur Dam built in 1933 is the main storage dam in the Cauvery basin, and both the Grand Anicut and the Upper Anicut regulate floods. Other important works in the basin within Tamil Nadu are the Lower Bhavani Project and the Amaravathi Reservoir.

All the rivers in the State are rain-fed and their maximum discharge occurs during the monsoon months. While the Cauvery and the Tambraparni have a greatly attenuated flow during the summer months, all the other rivers in the State dry up completely in the hot season. Table 18.5 gives the percentage of yield in some of the rivers for selected years.

Table 18.5

Annual & Seasonal Flows of Rivers of Tamil Nadu

Name of river/site	Total flow (m.cu.m.)	Percentage of yield			Years for which average has been worked out
		June-Sept.	Oct.-Dec.	Jan.-May	
1	2	3	4	5	6
Cauvery					
(a) Mettur Reservoir	10,785	68	24	8	1934-35 to 1968-69
(b) Grand Anicut	11,002	57	33	10	1930-31 to 1960-61 (Except 1956-57)
(c) Coleroon at Lower Anicut	4,413	43	45	12	1934-35 to 1963-64
Bhavani at Bhavani Sagar	2,274	53	29	18	1954-55 to 1968-69
Amaravathi at Pallapalayam Anicut	667	30	54	16	1934-35 to 1964-65
Palar at Palar Anicut	135	7	90	3	1919-20 to 1952-53 (Except 1943-44)
Ponnaiyar at Tirukoilur Anicut	634	15	74	11	1926-27 to 1957-58 (Except 1955-56)
*Vaigai at Peranai Regulator	1,102	25	49	26	1928-29 to 1959-60 (Except 1939-40 & 1952-53)
Tambraparni at Srivaikuntam Anicut	821	17	55	28	1931-32 to 1962-63 (Except 1940-41 & 1945-46)

*Includes diversion from Periyar river.

Hydrological Observations

18.8 There is no separate organisation in the State for carrying out hydrological observations and this work is done by the officers incharge of reservoirs and anicuts. The observations relate only to the supplies brought down and utilised under the related project. For major projects, however, the observations and readings include the daily flows at the gauge sites, the utilisation and the surplus.

An accurate assessment of the overall surface flows and the utilisation of flows in each river basin is at present impracticable, because, besides the controlled off-takes, there are uncontrolled off-takes along the courses of all the Tamil Nadu rivers. In addition, there are a large number of tanks from which surplus water runs into the rivers or into the sea.

Recently, an Investigation Circle has been formed in the State to make basin-wise studies and to assess the irrigation potential. However, since

most of the surface water flows have already been harnessed for irrigation, there is not much likelihood of any large quantity of water being available.

Irrigation Potential

18.9 The ultimate irrigation potential of Tamil Nadu from different sources is estimated as follows:

Surface sources.	(Thousand hectares)
(i) Major and medium works	1,560
(ii) Minor schemes	810
Ground water sources	1,320
Total:	3,690

Source: Fourth Five Year Plan and the Report of the Working Group on Minor Irrigation and Rural Electrification.

Development of Irrigation

18.10 As far back as 1903, when the First Irrigation Commission gave its report, there were 20 irrigation projects in operation in the State, irrigating 0.55 million hectares. From 1903 to the commencement of the First Five Year Plan, the following projects were executed.

(i) Toludur Project in South Arcot district;
(ii) Cauvery-Mettur Project in Thanjavur district;
(iii) Kattalai Project in Tiruchchirapalli district.

In addition, substantial improvements were carried out to the Grand Anicut and the Upper Anicut to regulate floods downstream in the delta. By 1951, a total of 24 major and medium projects were irrigating a total of 0.85 million hectares in Tamil Nadu.

During the First Plan nine irrigation projects were taken up to benefit a total area of 0.22 million hectares (including stabilisation of existing irrigation in old areas).

During the Second Plan, another 5 schemes were taken up to benefit an additional 0.12 million hectares. Another 12 major and medium schemes to benefit 0.135 million hectares were taken up in the Third Plan, three Annual Plans and the Fourth Plan. The more important of these projects are:

(i) Lower Bhavani benefiting 78,920 hectares
(ii) Khodayar Extension (Perinchani) benefiting 47,530 hectares

(iii) Parambikulam-Aliyar benefiting 91,130 hectares
(iv) Chittar-Pattanamkal benefiting 19,020 hectares
(v) Manimuthar benefiting 41,690 hectares
(vi) Amarvathy benefiting 21,660 hectares
(vii) Mettur Canals benefiting 18,210 hectares

18.11 Some of these projects are briefly described below.

Lower Bhavani Project

This project was included in the First Plan, although work on it had begun in 1949, two years before the beginning of the First Plan. It was completed in 1956 at a cost of Rs. 103 million, and consists of a masonry-cum-earth dam, 8,800 m. long and 62 m. at its maximum height. The gross capacity of the reservoir which has been constructed on the river Bhavani just below its confluence with the Mayur, in Coimbatore district, is 925 m. cu. m. with a live storage of 900 m. cu. m. An area of 78,920 hectares is irrigated by the project.

Parambikulam Aliyar Project

This ambitious project, contemplates the harnessing of seven west-flowing rivers, namely, the Nirar, the Sholayar, the Parambikulam, the Tunakadavu, the Peruvaripallam, the Aliyar and the Palar. The Aliyar and Palar flow to the east, while the remaining five flow to the west of the Ghats. While constructing dams across these rivers and connecting one to the other through tunnels, it is proposed to divert all their waters to the east, so as to irrigate 97,130 hectares in the Coimbatore district of Tamil Nadu. The project would also benefit about 10,000 hectares in the Chittur district of Kerala.

These rivers have their sources at various elevations ranging from 1,158 m. to 320 m. and it is proposed to take advantage of the difference in elevation to generate 185 MW of power. The details of the various structures involved are given in Table 18.6.

There are several features of this project worthy of note; the most important being that the main canal and the distributaries and the minors, down to the 20 hectare limit will be lined. It is, perhaps, the only project in the country in which lining is being done throughout almost the whole distribution system. Another important feature is that the field channels are being executed by the project, down to the 10 hectare limit. Beyond this limit, the field channels will be constructed by the cultivators. This feature is of particular importance for the rapid development of the ayacut.

Table 18.6

Parambikulam-Aliyar Project—details

Salient features	Nirar weir*	Sholayar dam	Parambikulam dam	Tunakadavu dam	Peruvari-Pallam dam	Aliyar dam	Tiru-murthy dam
1	2	3	4	5	6	7	8
Name of river	Nirar	Sholayar	Parambikulam	Tunakadavu	Peruvari-Pallam	Aliyar	Palar
Type of dam	Masonry weir	Masonry flanked by earth	Masonry with earth saddle dam	Earthen	Earthen	Masonry flanked by earthen dam	Earthen
Length (metres)	148	1,184	318	338	945	3,201	2,680
Maximum height (metres)	—	105	73	12	28	22	23
Gross stores capacity (m.cu.m.)	—	157	504	16	19	109	52
Live storage capacity (m.cu.m.)	—	147	346	10	13	109	47
Benefits irrigation				97,130 hectares			
Power				185 MW			
Cost				Rs. 675.3 million			
Date of commencement				1959			
Date of completion				During the Fourth Plan			

*Details regarding Nirar Weir are from Parambikulam Aliyar Project—A Brochure issued by Government of Tamil Nadu.

Construction work is being phased so that even before its completion in the Fourth Plan, the project will increasingly provide irrigation to areas in the ayacut. By the end of March, 1969, nearly 39,000 hectares had been thus irrigated.

Chittarpattanamkal Project

The project will consist of two earthen dams interconnected by channels across the Chittar river. One dam, 765 m. in length, will be 22 m. in height, and will have a gross storage capacity of 15.7 m.cu.m. The second dam will be 1,076 m. long, and 25 m. high, with a gross storage capacity of 27.2 m.cu.m. The project will also include gates in the Pechipara and Perichani dams, a feeder channel from the Chittar Dam to augment the supplies in the left bank canal of the Kodayar system, the excavation of a new Pattanamakal channel, and the improvement of various canals and channels. Its total cost will be of the order of Rs. 73.3 million. When the project is completed, it will benefit 19,020 hectares.

Manimuthar Project

Begun in 1950 and completed in 1958, this project in the Tirunelveli district consists of a dam across the Manimuthar, a tributary of the Tambraparni, with a gross storage capacity of 155 m.cu.m. The composite dam provides irrigation to 41,690 hectares.

Appendix 18.1 gives the salient features of projects irrigating 4,000 hectares or more each, which have either been completed or are under construction.

Minor Irrigation

18.12 Irrigation by tanks and wells has been practised for centuries in the State. Prior to 1951, tanks and wells accounted for more than half the total minor irrigation in the State. Of the total of 0.92 million hectares under minor irrigation, 0.5 million hectares were from wells. By 1964-65, the gross area irrigated by tanks and wells went up to 1.48 million hectares of which 0.81 million hectares were from wells.

Nearly 27,000 small tanks in the State provide irrigation. Where the topography permits, water is led from streams through inundation channels to feed tanks. The supply channels drawn from the Vaigai in the Madurai and Ramnad districts, are typical examples.

In the districts of Chingleput and North Arcot, supplies are drawn from spring-channels led off from below the sandy beds of streams where there are continuous sub-surface flows after the river runs dry. It is estimated that there are 6,000 such spring-channels.

18.13 There has been a marked development in the exploitation of ground water through tubewells, including filter points, from 1956 when there were only 2,649 tubewells, to 1969 when their number went up to 23,900. They are mostly privately owned and farmers can get loans from the Government for sinking them.

In the Cauvery delta, the irrigation season lasts from June of one year to January of the next year. Due to a late monsoon and the delayed filling of the Mettur Reservoir, the irrigation season in some years begins late. In such years, the paddy seedlings in the delta have to be raised with water drawn through filter points, which may also be used for wetting fields. The filter points exploit shallow aquifers. On the average a filter point can irrigate about 2-4 hectares of land. The State Government launched a crash programme for sinking filter points and 16,000 points have been sunk, mostly in Thanjavur and Tiruchchirapalli districts.

Ground Water

18.14 The total available surface water resources have been estimated by the State Government at 19,736 m.cu.m. of which 15,641 m.cu.m. had been utilised before 1951. The new projects taken up since then will utilise an additional 1,628 m.cu.m. leaving only 2,467 m.cu.m. for further development. It is clear, that the future expansion of irrigation will have to depend largely on the exploitation of ground water.

In this also, the performance of the State has been good. Nearly 25 per cent of the total irrigation in the State is done from wells. The Government has initiated a ground water survey of the basins of the Cauvery, Palar and Kortalayar and Arniyar and in the Neyveli area under the United Nations Development Programme. At the time of our visit, the UNDP experts were busy evaluating the ground water potential of Thanjavur district. In addition to the UNDP and the Ground Water Directorate, there are several other agencies doing investigation and development of the ground water resources in the State. These are:—

(a) the Central Ground Water Board;
(b) the Department of Agriculture;
(c) the Public Health and Highways Department;
(d) the Agricultural Refinance Corporation; and

While the efforts of the Departments of Agriculture and the Public Health and Highways and the private bodies are on a limited scale, the Agricultural Refinance Corporation has undertaken an ambitious programme of ground water development, including:

(i) 5,000 filter points and 1,000 shallow tubewells in the Cauvery sub-basin, and 2,000 filter points in the Vennar sub-basin;

(ii) 90 medium tubewells in the new delta area;
(iii) 100 medium tubewells and 300 shallow tubewells in Tiruchchirapalli district;
(iv) 2,500 shallow tube wells and 500 medium tube wells in South Arcot district;
(v) construction of new open wells, deepending of the existing wells, and the provision of pump sets in the four northern district of Chingleput, Salem, North Arcot and Dharmapuri;
(vi) similar schemes for Madurai, Ramanathapuram, Tiruchchirapalli, Tirunelveli and Coimbatore.

18.15 The net area irrigated from all sources at the end of 1967-68 stood at 2,629 thousand hectares against 1,811 thousand hectares in 1950-51. The source-wise details are as below:

Source	Irrigated Area (Thousand hectares)
Canals	893
Tanks	990
Wells	698
Other sources	48
Total:	2,629

The gross area irrigated in 1967-68 was 3,476 thousand hectares, indicating an intensity of 132% in the irrigated area. There was, a slight set-back to irrigation in the next year largely due to the failure of tanks, and the net and gross irrigated areas in 1968-69 were 2,417 and 3,092 thousand hectares respectively.

Inter-State Rivers

18.16 Almost all the rivers flowing through Tamil Nadu rise either in Mysore or in Kerala. As far back as 1892, the erstwhile Government of Madras and the then Princely State of Mysore had entered into an agreement regarding the use of the waters of the following rivers:

1. Tungabhadra
2. Tunga
3. Bhadra
4. Hagari or Vedavati
5. Penner or Northern Pinakini

6. Chitravati
7. Papaghni
8. Palar
9. Ponnaiyar or Southern Pinakini
10. Cauvery
11. Hemavati
12. Lakshmantirtha
13. Kabbani
14. Honhole or Suvarnavati
15. Yagachi, a tributary of the Hemavati up to the Belur Bridge.

A second agreement was concluded between these two States regarding the Krishnaraja Sagar Dam. Differences of opinion have recently arisen between the two State Governments in regard to the utilisation of the waters of the Cauvery. They have not yet been settled. Agreement has been reached, with the Kerala Government on the Parambikulam Aliyar Project, Bhavani and Pambar basins.

Incidence of Drought

18.17 Although Tamil Nadu gets on an average, 97 to 100 cm in both monsoons, nearly three-quarters of the State is deficient in rainfall and lies in the rain-shadow of the Western Ghats.

If we draw a line running from north to south, i.e., from Tirunelveli to Pattukkottai, it would roughly divide the State into two rainfall regions. To the east of the line would lie areas of higher rainfall, while to the west those of less rainfall, with the exception of the Nilgiris and Kanniyakumari districts.

The years 1965-69, when scarcity conditions prevailed over large parts of the country, were also bad years for Tamil Nadu. In 1966, the State Government appointed a Study Team to go into conditions in the worst-hit areas. This Team identified 31 taluks as drought-affected.

In all but one of these taluks, the average rainfall falls short of 90 cm, the exception being the Udayarpalayam taluk where the rainfall is about 100 cm. Generally, successful agriculture in areas of less than 90 cm of annual rainfall remains problematical unless they receive irrigation. In the taluks referred to above, whatever irrigation exists is derived from tanks, which usually dried up when the rains fail.

In addition to the 31 taluks identified by the Study Team, the State Government considered that there were 30 other taluks with equally inadequate rainfall but where irrigation facilities were marginally higher. The Government are considering whether these taluks also should be added to the list recommended by the Study Team. The population affected in the 61 taluks is 2.47 millions out of a total of 18.60 for the State.

The Commission has, in accordance with the criteria laid down in Chapter VIII of the First Volume of the Report identified 24 taluks as constituting the core areas of drought, which need special attention. They are the following:

Dharampuri District

1. Hosur
2. Krishangiri
3. Harur
4. Dharmapuri

Salem District

5. Sankari
6. Tiruchengode

Coimbatore District

7. Dharapuram
8. Palladam
9. Avanashi

Tiruchchirapalli District

10. Perambalur
11. Karur
12. Kolathur
13. Alangudi

Madurai District

14. Dindigul
15. Palani
16. Tirumangalam

Ramanathapuram District

17. Tiruvadanai
18. Paramakudi
19. Ramanathapuram
20. Mudukulathur
21. Aruppukottai
22. Sathur

Tirunelveli District

23. Koilpatti
24. Nanguneri

The Commission has recommended that some irrigation works under construction should be expedited and that some new works be taken up on a basis of priority. All these works will benefit the drought areas.

The projects are named below:

A. *Continuing Schemes*

(1) Parambikulam-Aliyar
(2) Modernisation of Vaigai Channels
(3) Gatana Reservoir
(4) Ramanadhi

B. *New Schemes Proposed*

(1) Chinnar
(2) Dodahalla
(3) Parappallar
(4) Improvement to Periyar Channels
(5) Marudhanadhi
(6) Ponnaniar

(7) Karuppanadhi
(8) Anicut across Vaippar Athankari
(9) Pilavaikkal Scheme
(10) Veniar Project
(11) Reservoir across Kodunagaripallam
(12) Noyyal Reservoir
(13) Kodiganur Scheme
(14) Reservoir at the Head of Vellar
(15) Kudhirayar Project
(16) Ghiriyar Project
(17) Pachayar Reservoir
(18) Kodamadi Reservoir

Other schemes for the relief of drought and scarcity areas proposed by the State Government, include the development of minor irrigation schemes, i.e., sinking of tubewells and open wells, extension of electricity to villages to energise pump-sets, extension of mechanised cultivation, and soil conservation measures. The total investment in this programme would be of the order of Rs. 720 million, and on fulfilment, it is expected to create additional production potential of 257 thousand tonnes.

Future Possibilities of Irrigation

18.18 The State Government is aware, that having already utilised 17,270 m.cu.m. of the 19,740 m.cu.m. of available surface flows, there is not much scope for major irrigation schemes. It has, therefore, included only medium schemes and the improvement of existing irrigation systems in the Fourth Plan, the most important of the latter being the modernisation of the Cauvery Delta System and of the Vaigai Channels.

Modernisation of Cauvery Delta System

We have dealt with the details of the modernisation of the Cauvery Delta System in the latter portion of this Chapter. Here, we would like to point out the benefits likely to accrue from the modernisation which are:

(a) addition of 1.54 million hectares to the total cropped area;
(b) relief to about 16,200 hectares of land periodically subjected to submersion and waterlogging;
(c) stabilization of irrigation in about 33,600 hectares of single cropped land in the Lower Coleroon Anicut System; and
(d) increase in the area under sugarcane and pulses by 8,100 hectares each.

The overall production of food is expected to increase from 1.5 million tonnes to 3.4 million tonnes per annum, or a gross increase of over Rs. 650 million annually, at current prices. The State Government has calculated that it will get an 8.2 per cent return on the investment.

Modernisation of the Vaigai Channels

The scheme envisages the construction of two regulators across the river, and of two channels on either side of these regulators, to feed a large number of tanks within the command of the channels. Apart from stabilizing irrigation over an area of 38,000 hectares, the scheme will provide additional irrigation to 5,640 hectares.

The State Government is also examining the possibility of diverting the waters of the west-flowing rivers through Kerala, to irrigate the scarcity districts of Ramanathapuram and Tirunelveli. Any such scheme will require the approval of the Kerala Government.

There are 41 west-flowing rivers in Kerala with a total annual yield of 72,520 m.cu.m. as estimated by the Government of Kerala, that a surplus of 40,490 m.cu.m. of water will flow to the sea after meeting the irrigation, power and navigational requirements of Kerala State*. A part of this surplus can, in our opinion, be usefully diverted to bring relief to the scarcity areas of Tamil Nadu where there is no other source of irrigation. It must be kept in mind that, since the diversion of water to irrigate the scarcity districts will have to be drawn from only the upper reaches of the rivers, the utilizable surplus will be only a part of the total surplus.

Floods and Drainage

18.19 Floods are not a serious problem in Tamil Nadu, because flood-control system existing there is of a high order. There are numerous dams, anicuts, regulators and other irrigation works in the basins of the Cauvery and other rivers flowing through the State. Moreover, protection to vulnerable areas has been provided by embankments, spurs and groynes.

Nevertheless, the Cauvery occasionally carries volumes of flood water which cannot be wholly contained or controlled. For example, in 1961, the Coleroon branch of the Cauvery, which is the chief flood-carrier of the river, breached its banks and the overflowing flood waters caused breaches in the banks of other rivers. A special committee, which made a study of the situation, recommended the following measures:-

(a) construction of a regulator across the Cauvery at the Upper Anicut;
(b) strengthening of the Cauvery and Vennar regulators;
(c) raising of flood banks; and
(d) strengthening of the flood-warning system.

Drainage is a serious problem only in the Vennar sub-basin during the north-east monsoon months. The problem is aggravated, because the higher

*Advance Report on Water Resourecs of Kerala

areas above the Vennar sub-basin drain into it. According to the State Government, 6,500 hectares out of a total of 16,200 in the sub-basin has poor drainage.

The remedies proposed include:—

(a) controlling the entry of flood waters into the Cauvery arm of the main river by constructing a barrage;
(b) diverting upland drainage away from the sub-basin;
(c) providing more outlets for the drainage water to reach the sea; and
(d) improvement to the existing drainage.

Some of these items are included in the Fourth Plan.

Water Rates

18.20 Water rates in the State vary from project to project, as will be seen from Appendix 18.2

Betterment Levy

18.21 Under the Madras Irrigation (Levy of Betterment Contribution) Act, 1955, as amended in 1963, betterment charges can be levied from the landholders whose land has benefited from a public work. Every acre of land in the ayacut of a new project is liable to pay a betterment levy at the rates given below:

Schedule of rates per acre

NEW AYACUT

	Wet Zone	Intermediary Zone	Irrigated Dry Zone
	Rs.	Rs.	Rs.
Block A	200	170	140
Block B	180	150	120
Block C	160	130	100
Block D	140	110	80

The levy is not chargeable in the ayacuts of projects completed on or after the first January, if the cost of the project does not exceed Rs. 1,50,000/-.

The new ayacuts were divided into zones on the following lines:-

(i) *Wet Zone:* A wet zone comprises all lands for which the water

supplied by a notified work would ordinarily be sufficient for one wet crop in a fasli year.

(ii) *Intermediary Zone:* An intermediary zone comprises all lands for which the water supplied by a notified work will occasionally be sufficient for one irrigated crop in a fasli year.

(iii) *Irrigated Dry Zone:* An irrigated dry zone comprises all the lands for which the water supplied by a notified work would be ordinarily sufficient for one irrigated dry crop in a fasli year, but not for wet crop.

The betterment contribution works out to one-third of the net expenditure on the project, per acre of land benefited. The net expenditure is calculated by deducting from the gross expenditure, twenty times the annual increase in revenue, if any, from the lands as levied before and after the irrigation. The contribution becomes recoverable two years after the completion of the work. It is paid in equal instalments of Rs. 5/- per acre or one-twentieth of the total contribution, whichever is higher. Arrears carry an interest of 6 per cent.

Tours, Observations and Impressions

18.22 We toured Tamil Nadu State from the 10th to the 15th May, 1971, visiting Madurai, Ramanathapuram, Tiruchchirapalli, Thanjavur and Coimbatore districts. Our tour ended at Madras, where we were able to have discussions with the Chief Minister, the Irrigation Minister and other Ministers, as well as with officers, including Secretaries to Government. Throughout the tour, we were accompanied by the Secretary to the Department of Irrigation and the Chief Engineer. The highlights of the tour were visits to the Grand Anicut and the Upper Anicut on the Cauvery, and areas in the Cauvery delta. We were also able to see a fair number of tanks and canals and to discuss irrigation problems with local officers, cultivators and prominent public-men. Our observations on what we found during this tour, are given below:

18.23 Generally speaking, the 'duty' that is to say, the number of acres irrigated per cusec of water, on most of the old irrigation systems, was very low. The 'duty' in the Thanjavur delta area, for example, was 40 to 45, and in the Kalingarayan Channel it was only 30 to 32. The reason given was that the old systems constructed in the 19th Century, needed improvements to function efficiently. Improvements are, no doubt, urgently called for, not only to prevent the wastage of water but also to extend the benefits of irrigation to larger areas. The existing systems should be critically examined and analysed, and where the duty is low, action should be initiated to improve its efficiency.

We gained the impression during our tours that many engineers were not feeling concerned about the fact that the 'duty' in projects under their charge was low. We are of opinion that the engineers in-charge should be made responsible for maximising the 'duty' on projects under their charge and if the 'duty' on any project is found to be low the engineer concerned may be asked to explain the reasons. Some encouragement, by way of the recognition of meritorious work should be given to engineers who keep the 'duty' at a high level.

The Cauvery Delta

18.24 We were able to discuss the proposed modernisation of the canal system in the Cauvery Delta with the Collector, irrigation engineers and others, in some detail. It was explained to us that the Cauvery Delta System, which has been in existence for a great many years, has become outmoded and inefficient, and that the cultivators at the tail-end do not get adequate water. The fact that irrigation is practised from field to field undoubtedly leads to the wastage of water. The normal drainage problems in the deltaic plain are aggravated by the fact that drainage and irrigation are both done through the same channels.

The total outlay on the project is estimated to be Rs. 490 million over ten years. The scheme will be executed in three phases. The first phase will take over four years and the second and third, three years each.

The main proposals involved in the modernisation scheme are the improvement of headworks, desilting of the river, construction of regulators across the main river and branch rivers, and the conversion of bed dams into regulators. Selected reaches of rivers and channels will be lined, and pipe sluices provided at all open off-takes. Field channels will be constructed under the project down to blocks of 20 hectares. There will be a systematic development of ground water through deep 'duty' tubewells and filter points. The drainage will be improved and will be done through separate channels. The modernisation will also include the construction of roads and communications, and farm works, that is re-levelling and re-bunding of fields.

We paid a visit to the Rajan Channel, one of the many channels taken up for modernisation. The irrigation from this channel was formerly done by putting up earthen cross-bunds at various places and cutting the banks to permit the outflow of water. The cross-bunds have now been replaced by masonry notches which raise the level and allow an appropriate quantity of water to flow down the channels. Outlets with hume pipes have also been constructed and the banks properly formed. We were informed by the engineer-in-charge of the scheme that instead of 2.27 cumecs previously

required, only half the quantity would be enough to irrigate the command under the channel.

The modernisation scheme will help to prevent or reduce the intensity of floods. It will improve the command of the rivers and channel regimes, reduce seepage losses and take irrigation to, and drainage from, each field. It will also enable an equitable and concurrent distribution of water from the head to the tail-end of each channel.

A striking feature of the scheme, is the proposal to utilize up to 1,784 m.cu.m. of ground water conjunctively with surface flows for irrigation.

The research wing of the Agriculture Department is doing trials on special high-yielding paddy strains of short duration for introducing a new pattern of double cropping.

We were able to discuss with UNDP expert the ground water aspect of the scheme at some length. We learnt that it was proposed to bore several thousand filter points and more than a thousand deep tubewells to supplement surface flows, particularly to ensure the growth of paddy seedlings well in advance of 12th June, when the irrigation season opens and water is let out from the Mettur dam. We were greatly impressed with the thorough manner in which the ground water survey was being conducted and trust that this venture in ground water exploitation will prove to be of inestimable benefit to the delta in the coming years.

We discussed the financial implications of the modernisation scheme, first at Thanjavur and then a second time with the Chief Minister and his colleagues at Madras. We were informed that the State Government proposed to enhance the water rates and to recover a betterment levy in the delta. We would venture to suggest, in general, that the returns to the Government from the modernisation scheme should be adequate and in no case should they cast any additional burden on the State Exchequer. We made it clear to the Chief Minister that if the returns are inadequate to meet the maintenance and interest charges, it would mean that dry areas like Ramanathapuram with little or no irrigation, will have to bear a part of the additional burden. In this connection, even at the cost of being repetitive, we would like the State Government to bear in mind the remarks of the First Irrigation Commission quoted by us, with approval on pages 264 and 165 of the First Volume. These remarks are even more relevant to productive works like the Cauvery Delta.

The general approach to the question should be guided by two considerations, firstly that the water rates should be fixed bearing in mind the capacity of the irrigator to pay, and, secondly, that the State should get its due share of the value of increased production from irrigation. We have dealt with the economics and financing of irrigation works in Chapter XI of the First Volume.

Water Management

18.25 We were greatly impressed by the experimental water management carried out successfully in the village of Siddhamali within the Cauvery Delta. About 160 hectares of land belonging to 21 farmers has been parcelled into 0.4 hectare plots, each of a rectangular shape. In place of the irregular, zig-zagging field bunds, narrow and straight bunds, enclosing each rectangular plot, have been formed. Instead of the field to field irrigation which was previously done, water now reaches each field through field-channels along the boundary of each plot. To prevent inundation, embankments of appropriate size have been raised along the existing channels and drains. The cost per hectare is estimated to be about Rs. 445. We were informed that the improvement in the efficiency of irrigation and drainage has increased production by about 0.62 tonnes per hectare under high-yielding varieties of rice. The area of double cropping has increased, and the straightening of the earthen bunds and the reduction in their width has increased the cropped area by 1.5 per cent. An incidental, but important, advantage due to the reduction of the bund-width, is the lessening of the rodent menace.

The cost of improvements is recoverable from farmers in ten equal annual instalments with interest at 7 per cent, the first payment commencing two years after the completion of the work. The Siddhamali experiment points the way to a simple, yet effective, method of making both irrigation and agriculture more efficient and productive. We would recommend that this work may be taken in hand throughout the State.

Drought Affected Areas

18.26 We visited some tanks in the drought-affected areas of Ramanathapuram district. The Srivilliputhur taluk is badly drought-affected and it was no surprise that the tanks there were all dry. We were informed that the tanks had not had water for the last four years. Some irrigation is carried on from shallow wells sunk in the bed of tanks. The crying need for irrigation is evident from the fact that out of 607 thousand hectares sown in the district, only 212 thousand hectares are said to be irrigated—182 thousand hectares from tanks and the balance by wells. In bad years of small or no rainfall, the tanks dry up and the water level sinks in the wells. In such years there is virtually no irrigation.

The State PWD is investigating a scheme involving the construction of a dam, a pick-up weir and a tunnel through the hills to bring Vaigai waters to Srivilliputhur taluk. The farmers wanted the investigations to be expedited. They also pressed that the deforestation of the hills in the catchment of the Vagai should be stopped.

We were glad to see the progress of work on the repair of 7,500 odd ex-zamindari tanks in the district, most of which had fallen into disrepair. Nearly 500 of the tanks serve areas measuring 80 hectares or more each. Under the law, the responsibility for the maintenance and repair of these tanks rests with the PWD. The smaller tanks after repair are handed over to the Panchayat Unions for maintenance. As many as 3,102 tanks have already been repaired, and work on 608 tanks is in progress.

In Virudhunagar, we saw a big well which had been dug by the Union at a cost of Rs. 40,000/- to give the last watering needed to mature the crop. We are glad that the Panchayat Unions are doing good work in conserving water and in constructing tanks.

We suggested to local officers that during the rainy season only short-term varieties of rice should be grown which could mature without irrigation, and that the water in the tanks should be conserved to give light irrigation to a second dry crop. The local officers, however, feared that farmers may not grow rain-fed rice when they can grow irrigated rice which is more profitable.

We are of opinion that in all areas of low rainfall the rain water should be conserved to the maximum possible extent by raising field bunds. We could get no information of how much dry area is bunded at present.

During discussions with local officers and farmers, we were given to understand that only one-third of the Cauvery delta had double cropping of paddy. According to them the shortage of labour was the main reason for the low percentage. We suggested that mechanization of farming may be a solution but were told that some processes in paddy cultivation necessarily required manual labour. We would suggest that a study be made of the Japanese methods of paddy cultivation, which is almost wholly mechanized.

We were happy to notice the highly intensive cultivation on both sides of the highway from Tiruchchirapalli to Erode. This belt is extremely fertile and is irrigated by channels from the Cauvery. Most of this area is double cropped. We were told that, in addition to two crops of paddy, a third crop of til (gingelly) sometimes is grown with the residual moisture after harvesting the second paddy crop.

Pugalur River Pumping Scheme

18.27 We were supplied with the details of a pumping scheme near Karur, planned by the Pugalur Irrigation Co-operative Society. The idea is to irrigate by lift an area of 1,490 hectares of dry land on the southern side of the Pugalur Channel which runs parallel to the south bank of the Cauvery. The scheme will have 14 pumping stations, with heads varying

from 13.4 m. to 35.7 m. Its total cost is estimated at Rs. 11.2 million. We went to a smaller pumping scheme run jointly by several farmers in the same area. For an irrigated area of 104 hectares, the cost of the scheme came to Rs. 225 thousand in 1961. We found an excellent crop of sugarcane standing in the field. We are of the opinion that the Government should give encouragement to co-operative ventures like this, if the farmers are willing to lift water.

Kalingarayan Channel

18.28 We saw this channel which takes off from an anicut of the same name across the river Bhavani and is said to have been excavated about four hundred years ago. The channel is about 92 km in length and has 769 outlets of varying sizes from 7.6 cm to 30.5 cm in diameter. These outlets serve an ayacut of 6,371 hectares. The full supply discharge in the channel is 580 cusecs. The 'duty' works out to 13 hectares per cusec against the normal of 24.48. It was obvious that much water is going waste. Besides, there is unauthorised irrigation through lift pumps on the right bank of the channel. We were given to understand that a scheme for remodelling was under consideration in order that the tail-end farmers may get water. We are of the opinion that this scheme should be implemented expeditiously.

We would suggest, if it is feasible, that the whole or a part of the area on the right bank may be included in the command of the channel, provided, that the existing tail-end farmers are not made to suffer.

Chambarampakkam Tank

18.29 This tank is about 26 km south-west of Madras City. It is the biggest tank under the charge of the PWD. It has been in existence for some hundreds of years. The tank has a free catchment of 77.13 sq. km and a combined catchment of 357 sq. km. It receives the surplus waters of 219 smaller tanks in the catchment, and also water from the Palar and the Kortaliyar rivers. The ayacut under the tank measuring 5,435 hectares is spread over 38 villages. Flow irrigation is supplied through distributaries and field channels, and there are also 1,500 pumping sets scattered over the ayacut for supplemental irrigation.

We were told that the tail-end farmers do not get an adequate water supply because the channels have silted up and the masonry works are not properly maintained. Encroachments on channels, uneven distribution of water and violation of roster, were among other reasons mentioned. We understand that a special sub-division has been formed to investigate and prepare a plan for modernising the system.

Discussions at Madras

18.30 We were able to discuss the position of irrigation in general with the PWD Minister and the Secretary, PWD and other officers. The main point made out by them was that Tamil Nadu has practically exhausted all its available surface water. Apart from the modernisation of existing systems, there was not much scope for increasing the area under irrigation from surface flows. The only hope lay in diverting water through the Western Ghats from Kerala.

There is no doubt that a large proportion of the water of west-flowing rivers in Kerala was going to waste. Tamil Nadu contributes 4,134 m. cu.m. of water to the west-flowing river from catchments which lie in the territory of Tamil Nadu. The State Government wants, in addition to Tamil Nadu's contribution, 2,175 m.cu.m. of water from the west-flowing rivers. We suggest that the Tamil Nadu Government may take up this matter with the Government of Kerala and we trust that the Kerala Government would respond generously.

The issue of constructing a link between the Ganga and the Cauvery was raised by the representative of the State Government. We explained to them that we had no objection to the project, in principle, but that a project of this magnitude would require many years of detailed investigations. There were also a large number of less expensive schemes close at hand, which would need priority over this gigantic project.

Several other matters were discussed in our meeting with the Chief Minister and the Irrigation Minister. The first related to the low level of water rates in the State. We pointed out that although the modernising scheme of the delta is estimated to provide a return of $8\frac{1}{2}$ per cent, the estimate does not make any allowance for the interest to be paid to the World Bank. If that interest is taken into account the net return may be negligible. We would like the financial aspects of this scheme to be re-examined so that the new water rates are fixed at proper levels.

The second point made was that under the present system of irrigation obtaining in the State, the functions of the irrigation engineer end at the outlet. He has no concern with the financial aspects of the irrigation system under him. He is also not given adequate powers to prevent unauthorised irrigation. We feel that, in both these matters, a change is called for, and we would suggest that the irrigation rates should be assessed by the Irrigation Department, but the collection of dues could remain, as at present, with the Revenue Department. We would also suggest that enough powers be given to the Irrigation Department to prevent unauthorised irrigation.

CHAPTER XIX

TRIPURA

Tripura is situated at the south-western tip of Assam and is bounded on the east by Mizoram and on the south and the west by Bangladesh. The State comprises mostly hilly area intersected with flat cultivable lands along the banks of the rivers. The rivers in Tripura flow in Bangladesh after traversing 100-200 km. The slopes are very gentle and this causes floods during the rainy months. Most of the flow occurs in the monsoon season from May to October. The flood problem has been further aggravated by the construction of embankments lower down the river.

19.2 Till the end of the Second Five Year Plan, there was practically no irrigation in Tripura State. With the influx of population from across the border, the pressure on land has increased and there has been a growing demand for irrigation.

19.3 Irrigation and flood control in the territory are intimately interlinked because the cultivable lands are situated in the flat river valleys, and if the land is to be cultivated it has to be protected against floods. Only after it has been protected from floods, can irrigation water be given to raise crops.

19.4 So far no detailed investigations have been carried out for any major or medium irrigation schemes. Proposals have been examined to utilize the regulated releases from the Gumti Hydroelectric Project. There appears to be scope for a number of lift schemes but their details have to be investigated. The Geological Survey of India have started exploratory work in the Tripura State, and some preliminary investigations have been made to determine the ground water resources.

CHAPTER XX

UTTAR PRADESH

Uttar Pradesh is the fourth largest State in the Indian Union with an area of 294,413 sq.km. The rivers Ganga, Yamuna, Ramganga, Sarda, Gomti, Ghaghara, Gandak and Son are some of the major rivers which flow through the State, the Ganga being the main river and others its tributaries.

The Upper Ganga, Lower Ganga, Eastern Yamuna, Agra and Sarda Canals which irrigate more than 2 million hectares, are among the largest and oldest canal systems in the country. The first four were built in the nineteenth century. The Upper Ganga Canal, a major work of that period was designed and constructed by Col. Sir P. Thomas Cautley about a century and a quarter ago.

The Sarda Canal System was built in the twenties of the present century as a result of the support lent to this proposal by the First Irrigation Commission, despite strong initial resistance from the taluqdars. Prior to Independence, ten medium canal systems were constructed during the first half of this century. In addition, tanks, medium size reservoirs, over a million open wells, and last but not the least, thousands of State and Private tubewells constitute a fine network of minor irrigation works all over the State. Since Independence, Uttar Pradesh has continued to lay great stress on developing her irrigation potential. The Matatila Dam across the Betwa was the first major storage work undertaken in the Second Plan. The Ramganga River Project across the Ramganga, the Gandak Project, a joint venture of Bihar and Uttar Pradesh and Sarda Assist are all major projects under construction at present.

The State's population of 88.37 million in the 1971 census constitutes 16 per cent of the country's population and makes it the most heavily populated State.

Agriculture is the predominant occupation of the people with 75 per cent of the working population depending on it for livelihood. 86 per cent of the population lives in villages.

Uttar Pradesh's principal crop is wheat followed by rice. Other important crops are barley, jowar, gram, sugarcane and oilseeds.

Physiography

20.2 The State has three main physical divisions, i.e. the mountainous Himalayan region in the north, the Gangetic plain in the centre and the low hills and plateau land in the south. The Himalayan region comprising the districts of Uttarkashi, Chamoli, Pithoragarh, Tehri, Garhwal and Almora and the hilly part of the districts of Nainital and Dehradun is thickly forested below the timber line. Cultivation is done either in river valleys or on hill slopes. While rice and wheat are the main crops, the land under orchards is increasing. Some tea is also grown in Dehradun district.

The most heavily cultivated areas are in the alluvial Gangetic plain which also contains most of the population of the State. The northern part of this region consists of the bhabhar and tarai which are damp, marshy and thickly forested areas at the foothills. The bhabhar strip which is adjacent to the hills extends over the districts of Saharanpur, Bijnor, Garhwal, Nainital, and Pilibhit. The terai to the south of the bhabhar extends over the districts of Saharanpur, Bijnor, Nainital, Rampur, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria. The main crops of the bhabhar and tarai belts are wheat, rice and sugarcane. The rest of the Gangetic plain is alluvial and forms one of the most fertile regions in the country. About 70 per cent of the plain is cultivated.

The southern region of the State consists of low hills and plateau lands. It comprises the districts of Jhansi, Jalaun, Hamirpur and Banda, the Moja and Karchana tehsils of district Allahabad, a part of the district of Mirzapur lying to the south of the river Ganga and the Chakia tehsil of district Varanasi. A part of this region is not suitable for cultivation on account of the shallow soil cover and undulating topography. About 50 per cent of this area is under cultivation, the main crops being wheat, gram and jowar.

Soils

20.3 A wide variety of soils is met with in different parts of the State. The soils in the northern mountainous part are generally shallow and are (i) red loams along the slopes of the lower hills or along ridges, (ii) brown forest soils (iii) podsol on mild slopes and in pockets of hills and ridges and (iv) meadow soils near streams. The sub-montane tracts have porous and pebbly soils varying from clay loams to sandy loams.

The soils in the Gangetic plains fall into two broad categories i.e. (i) older alluvium (Bangar) and (ii) newer alluvium (Khadar). The soil composition differs from one region to another. The western tarai area (districts Nainital and Dehradun) consists mainly of shallow dark grey soils varying from loam to sandy loam. The western districts of the plains, i.e. Saharanpur, Muzzaffarnagar and Meerut have similar soils but of greater depth and very

fertile. Farther east, in Bareilly, Pilibhit, Bijnor and Moradabad, the soils are heavy loams and are generally somewhat alkaline. The soils of the central part of the plains comprising the districts of Kheri, Sitapur, Hardoi, Lucknow, Kanpur, Barabanki, Jaunpur and Azamgarh are slightly acidic loams and sandy loams. In drier parts, saline and alkaline efflorescences (known as 'Usar' or 'Reh',) occur in the soils, specially in the districts of Aligarh, Mainpuri, Kanpur, Sitapur, Unnao, Etah, Etawah, Raebareli and Lucknow.

The main soils occurring in the eastern parts are (i) 'Bhat' soils, generally low lying and sandy loam in texture with a high lime content (ii) 'Banjar' soils varying from loam to sandy loam with a low lime content and slightly alkaline to slightly acidic in reaction and (iii) some 'Dhub' soils near river banks.

The southern part of the State consists of mixed red and black soils. The black soils ('Mar' and 'Kabar') are clayey, calcareous and expansive and fertile. The red soils ('Parwa' and 'Rankar') generally occur on the top of plateaus and on the upper slopes of hills.

Climate

20.4 The State has a tropical climate, but there are great variations of temperature on account of altitude. The Himalayan region has a very cold climate except in the valleys where the cold is less intense, and where the summers are warm. Snow is precipitated from December to March and some of the higher mountain peaks remain under perpetual snow. In the plains, the average temperature varies from a minimum of about 3-4°C in January to a maximum of 43-45°C in May and June. The year may be broadly divided into 3 distinct seasons; the cold season from October to February, summer from March to mid-June and monsoon from mid-June to September. Practically all the rainfall occurs during the monsoon period.

Rainfall

20.5 The annual rainfall in the State varies from region to region. It is roughly 100-200 cm. in the Himalayan region, about 100 cm. in the sub-Himalayan belts of the bhabhar and the tarai, about 60-100 cm. in the west and central Gangetic plain and between 100-200 cm. in the eastern plain. The southern hills and plateau get a rainfall of over 100 cm but portions of the Jhansi and Banda districts and the whole of the Jalaun and Hamirpur districts get less. Nearly 87 per cent of the annual rainfall is received during the period from June to September and about 7 per cent during the winter months.

Land Use and Cropping Pattern

20.6 Table 20.1 gives the land utilization statistics for Uttar Pradesh for the year 1968-69.

Table 20.1

Land Use Details—Uttar Pradesh

Classification	Area in thousand hectares	Percentage to the reporting area
1	2	3
Geographical area	29,441	—
Reporting area	29,585	100.0
Forests	3,979	13.4
Barren and unculturable land	2,475	8.3
Land put to non-agricultural use	2,009	6.8
Culturable waste	1,397	4.7
Permanent pastures and grazing land	76	0.2
Land under misc. tree crops and groves not included in net area sown.	810	2.7
Current fallows	821	2.7
Other fallow land	602	2.0
Net area sown	17,416	59.0
Area sown more than once	4,944	16.3
Total cropped area	22,360	75.3
Net area irrigated	6,562	22.2
Gross area irrigated	7,559	25.5
Percentage of net area irrigated to net area sown		37.7
Percentage of gross irrigated area to gross area sown		33.8

20.7 During 1968-69 the following principal crops were grown over areas indicated against each:

Rice, jowar, bajra and maize are the principal kharif crops which are sown in June and July and harvested in October and November. Wheat, barley and gram are the main rabi crops sown from October to December and harvested from March to April. Some oilseeds are grown in kharif and others in rabi. Sugarcane is also an important crop. It is sown in February and March and harvested from November to March.

Foodgrains occupy about 84 per cent of the total cropped area in the State, which produces about 17.6 per cent of the country's total foodgrains. Among foodgrains, wheat and rice are the major crops, the former occupying about 22.7 per cent and the latter about 19.1 per cent of the total cropped area in the State. The area under wheat is about 32.4 per cent and under

Table 20.2

Principal Crops Grown in Uttar Pradesh

Crop	Area in thousand hectares	Percentage to total croped area
1	2	3
Rice	4,261	19.1
Wheat	5,067	22.7
Jowar	826	3.7
Total cereals	14,910	66.7
Gram	2,188	9.8
Total pulses	4,006	17.9
Total foodgrains	18,916	84.6
Sugarcane	1,203	5.4
Oilseeds	633	3.0
All crops	22,360	100.0

rice about 11.9 per cent of their total area in the country. Likewise, the production of wheat and rice is 33.0 per cent and 8.3 per cent respectively of their total production in the country. The State ranks first among the wheat-producing and sixth amongst the rice-producing States.

The other foodgrain crops grown in the State are barley, jowar and gram. The State produces 50.7 per cent of the country's total production of barley and 31.4 per cent of gram, ranking first among all the States. In non-foodgrain crops too, the State's contribution to the country is the largest viz., 20.8 per cent of oilseeds and 41.5 per cent of sugarcane.

Water Resources

Surface Water

20.8 The three main rivers, Yamuna, Ganga and Ghaghara running more or less parallel to each other from north-west to south-east carry the drainage of the vast fertile plains of Uttar Pradesh between the foothills of the Himalayas and the Vindhyas. The Ganga emerges from the mountains at Hardwar. It is joined on the right (southern) bank by the river Yamuna at Allahabad. The important tributaries of the Yamuna are the Chambal, Betwa, Dhasan, Ken and Tons rivers. The Ramganga and Deoha meet at a point a little upstream of their confluence with the Ganga on its left (northern) bank. Likewise, the Gomti also outfalls into the left bank of the Ganga about 16 km. from Jaunpur. The Ghaghara flowing from the

Himalayas runs to the left of the Ganga and joins it opposite Chapra in Bihar just beyond the boundary of Uttar Pradesh. The Sarda and Rapti are important tributaries of the Ghaghara meeting it on its right and left bank respectively. Along the banks of the Ganga and its tributaries are situated many important places of pilgrimage like Hardwar, Allahabad and Varanasi, historic cities like Delhi and Agra and education centres like Roorkee, Lucknow, Allahabad and Varanasi.

20.9 There is no regular organisation in the State for hydrological observations and the assessment of surface water resources. Discharges of rivers and drains falling within, or close to the command of, State irrigation systems are observed by the staff of the Irrigation Department. Gauges of rivers at bridges maintained by the Public Works Department are observed by that department. Gauge sites are fixed and discharge observations made for other rivers and streams where a major irrigation work on them is proposed.

River gauging on important rivers, specially those from which diversion canals take off, has been done for the last fifty to one hundred years. The gauges generally pertain to the point of off-take of the canals or to a point close by. These observations are entered in the gauge registers of the officer. They are not published.

In addition the Union Ministry of Irrigation and Power has set up the Ganga Basin Water Resources Circle, which is carrying out, *inter-alia*, gauge discharge and silt observations at some key stations in Uttar Pradesh and Bihar.

20.10 Table 20.3 gives the salient features of some principal rivers as furnished by the State Government in reply to the Commission's Questionnaire.

Though no proper survey has yet been undertaken, it is estimated that the total water resources of the Ganga basin are about 432,000 m.cu.m., out of which about 308,000 m.cu.m. pass through the State.

Ground Water

20.11 Systematic ground water surveys have been taken up only recently. A realistic assessment of overall ground water resources of the State cannot, therefore, be made. The ground water surveys in the Fourth Plan period are estimated to cost Rs. 15.29 million. A ground water cell has been set up recently to make sub-basin-wise estimates.

At the end of the First Plan, there were 0.66 million wells in use for irrigation. The number increased to 0.92 million at the end of the Third Plan

Table 20.3

Salient Features of Principal Rivers

River	Catchment area in sq. km.	Normal rainfall cm.	Average flow in m.cu.m.					Year for which the average has been worked out
			June-Sept.	Oct.-Dec.	Jan.-March	April-May	Total	
1	2	3	4	5	6	7	8	9
Yamuna (at Okhla)	18,250	66.09	—	—	—	—	9,371	1964-68
Yamuna (at Agra)	N.A.	51.80	58	Not observed	8	7	N.A.	1964-68
Ganga (at Hardwar)	32,357	105.7	15,952	2,447	1,507	1,487	21,393	
Sarda (at Banbassa)	15,165	153.7	15,576	3,475	1,260	1,032	21,342	1959-69
Betwa (at Matatila Dam)	26,893	65.24	6,870	120	29	3	7,022	1964-68
Dhasan (above Pahari Dam)	7,348	81.95	3,964	26,108	Not observed	Not observed	N.A.	1964-68
Pahuj (at Pahuj Dam)	311	68.26	50	331	722	-do-	N.A.	1964-68
Shahzad (at Lalitpur Dam)	368	75.96	71	748	122	—	941	1964-68
Jamni (at Jamni Dam)	410	105.88	5	N.A.	N.A.	N.A.	N.A.	N.A.
Ken (at Gangau)	18,429	85.3	4,979	228	36	12	5,256	1964-68

i.e. 1965-66. The area irrigated from ground water was 2.35 million hectares at the beginning of the First Plan and it rose to 3.62 mlliion hectares in 1968-69. According to the State Government, about 6,200 m.cu.m. are at present being drawn annually from the sub-soil through tubewells and masonry wells.

The State Government itself started a programme of the drilling of tubewells in 1931. Under the programme 1,656 tubewells were intended to be bored largely to serve areas in Meerut and Rohilkhand divisions. Later on, in 1945, a project for the construction of 600 additional tubewells in the same area was taken up and completed in 1951. The total number of State tubewells at the end of March 1946 was 1,847 with a capital outlay of Rs. 24.4 million. The cost per tubewell worked out to Rs. 13,210/-. An aggregate area of 0.31 million hectares was irrigated during 1945-46.

During the period 1946-47 to 1950-51, both inclusive, 458 tubewells at an average cost of Rs. 44,800 each were built, involving an outlay of Rs. 20.5 million. Thus towards the end of March, 1951 the number of State tubewells rose to 2,305 and the area irrigated by them to 0.38 million hectares. The number of State owned tubewells was 10,173 in March, 1971.

Most of the State tubewells are of 0.04 cumec discharge. The command area of each tubewell is now being reduced from 200-240 hectares to about 120 hectares, to meet the water requirements of high-yielding varieties. Tubewells with a 0.08 to 0.2 cumec discharge are now being bored as an experimental measure.

The number of private tubewells has also increased and the figures for works utilizing ground water in March 1969 are shown below:

(i) State tubewells (as on 31.3.71)	10,173 Nos.
(ii) Private tubewells	117,899 ,,
(iii) Open wells (pucca)	1,122,560 ,,
(iv) Area irrigated annually by the above works	2,956,120 hectares.

Present Stage of Development of Irrigation

20.12 The construction of the Eastern Yamuna and Upper Ganga Canals during 1830-1854 was the first and most significant effort in large-scale irrigation in Uttar Pradesh. Irrigation in Uttar Pradesh till then had been mostly from wells.

The Eastern Yamuna Canal takes off from the Yamuna river at Tajewala opposite the take off of the Western Yamuna Canal. Originally excavated in the reign of Mohammed Shah (1718-1748) it seems to have fallen into disuse and renovated by the British in 1830. A permanent head regulator

for the canal was constructed between 1872-78 and the river supplies at Tajewala shared between the two canals. The area irrigated by the canal in 1967-68 was 0.21 million hectares.

Designed and constructed by Sir Cautley of the Bengal Artillery, the Upper Ganga Canal was not only the largest irrigation canal in the world at the time but in many respects, it also served as a model for some of the later large canal projects. The canal takes off from the Ganga at Hardwar where the river emerges from the Himalayas. In 1897, an escape was constructed near Hardwar to discharge surplus water from the supply channel back into the river. Its permanent headworks consisting of a weir 548.6 m. in length was put up between 1913-1920. The Ranipur and Pathri superpassages, the Dhanauri level crossing and the Solani aqueduct are some of the big cross-drainage structures on the canal. The area irrigated by the canal in 1967-68 was 0.72 million hectares.

The Lower Ganga Canal was constructed during the period 1870-78 and a 1,158.24 m. long weir was constructed across the river at Narora in district Bulandshahar which has recently been replaced by a barrage. The gross area irrigated by the canal is 0.59 million hectares. The aqueduct over the Kali Nadi built after the flood of 1884 was one of the finest cross-drainage works in India.

The Agra Canal takes off from the right bank of the river Yamuna about 11 km. below Delhi near the village of Okhla from a 743.1 m. long weir. The 259 km. long main canal and the weir were constructed between the years 1868 and 1873. The waters of the Yamuna are supplemented by the waters of the Hindon through a diversion channel known as the Hindon-cut as well as by the waters of the Ganga Canal *via* the Jani escape. The gross area irrigated by the canal is 0.16 million hectares—mostly in rabi. This canal has very little kharif irrigation.

The Betwa Canal was the first protective work to be constructed in India between 1881-86 to benefit areas vulnerable to drought. The headworks of the canal on the river Betwa at Parichha about 27.4 km. from Jhansi, consist of a weir 1,298.7 m. long. In 1910, a second weir was built about 40.2 km. upstream of Parichha. The canal has protected the area from famine. The gross area irrigated by the canal is 0.12 million hectares.

20.13 Following the report of the First Irrigation Commission, two important works, the Ken Canal and the Sarda Canal were taken up. The Sarda Canal Project is a diversion scheme taken up in 1915 and substantially completed by 1927. The canal headworks are situated on the Sarda river at Banbassa in district Nainital, a few kilometres below the point where it debouches from the hills. At this point, the river forms the boundary between India and Nepal. The Nepal Government exchanged a small piece of territory with the Government of India to enable the left abutment

of the weir and the left bank works to be located within Indian territory. The barrage is 609.6 m. long. The canal takes off from the right bank of the river. It was originally designed to carry a discharge of 226.5 cumecs only. Of this discharge, 42.5 cumecs was fed into the Kichha river through the Sarda Kichha Feeder (taking off from the main canal near its eleventh km.), for utilization in the Rohilkhand Canal System. The canal was remodelled later, to carry a maximum discharge of 356.6 cumecs at the head out of which 31.1 cumecs is passed into a silt ejector for ejecting excessive silt charge back into the Sarda river. The net discharge available for irrigation and generation of power is 325.5 cumecs. The capital cost of the Sarda Canal Project was Rs. 194.5 million inclusive of the cost of remodelling. The length of irrigation channels was 9,505 km. and gross area irrigated was 0.72 million hectares in 1967-68.

The canal systems described above are all diversion works where the run-of-the-river is diverted into the canal by putting up a barrage or a weir across the river. Since these systems tap snow-fed rivers, the river supply fluctuates considerably in different parts of the year. The rivers carry enormous flood waters in the monsoon season but the flows dwindle during the winter. Again during the summer when the snows melt, the supplies commence to increase from the month of May. Thus a gross inadequacy in supply occurs during the rabi season, when the river is at its lowest. Premonsoon kharif crops also suffer from inadequacy up to May. If the rains fail, the inadequacy is also felt during September and October for irrigating paddy, and paleva irrigation for rabi.

During the period of low supplies, the distributaries and branch canals have to be run in rosters generally of 1:3 to 1:5, which means that they are open for one week in a period of three weeks to five weeks. The irrigation during the period when the distributary is open is done according to a system of roster called 'Osrabandhi'. According to this, each cultivator gets irrigation water in his turn for a certain period in the week in proportion to the area cultivated by him in the culturable command area of the outlet.

The cultivator is free to choose his crops and the rotation in which they should be grown. He develops his own cropping pattern and decides for himself the acreage to be irrigated in each season.

The intensity of irrigation in most of these systems has been kept low so that the maximum area is benefited by irrigation. Other reasons that accounted for low intensity, were the existence of large number of wells in the command areas and the fear of waterlogging.

Table 20.4 gives a list of projects each costing more than Rs. 10 million undertaken since 1951. Some of these works have been taken up for enlarging the present irrigation system, while others were built with the object of improving the intensity of irrigation. Large-size canal pumping schemes on perennial rivers have also been undertaken in Uttar Pradesh.

Table 20.4

Projects Costing More Than Rs. 10 Million Undertaken Since 1951

Project	Cost (Rs. million)
(a) *Completed*	
1,062 miles extension of Sarda Canal	11.38
Nanak Sagar	42.04
Tumaria Extension	27.00
Sarda Sagar Stage I	47.26
Sarda Sagar Stage II	73.23
Remodelling the Narora Weir	39.70
(b) *Under Construction*	
Haripur Reservoir	26.83
Kosi Irrigation Schemes	28.80
Sarda Assist Project	996.00
(c) *Works South of the Yamuna*	
(i) Reservoir/schemes completed	
Rangwan	12.84
Arjun	11.70
Naugarh Dam	13.63
Belan and Tons Canal	27.92
Jirgo Reservoir	12.52
Matatila Dam	124.60
Meja Reservoir	33.40
Musakhand Dam	31.50
(ii) Under Construction	
Jamni Dam	37.20
Chandrawal Dam	10.00
(d) *Other Works*	
(i) Completed	
Tumaria Reservoir	21.63
Pilli Dam (Reservoir)	24.00
Baur Reservoir	34.00
East Baigul Reservoir	10.66
(ii) Under Construction	
Ramganga River Project	956.40
Western Gandak Canal (U.P. share)	506.40
Tehri Dam*	2,000.00

*The project has been cleared by the Technical Advisory Committee in February, 1972. But the formal sanction/approval by the Planning Commission is awaited.

Table 20.4 contd.

Projects Costing More Than Rs. 10 Million Undertaken Since 1951

Project	Cost (Rs. million)
(e) *Pumped Canals*	
(i) completed	
Dohrighat Pumped Canal	17.51
(ii) Under Construction	
Dalmau Pumped Canal Stage I	16.40
Zamania Pumped Canal	11.80
Bhopauli Pumped Canal	10.60
Tons Pumped Canal	17.50

20.14 A brief description of the major projects is given in the paragraphs below:

Sarda Sagar and Nanak Sagar

During the Second Five Year Plan, two storage schemes viz., Sarda Sagar and Nanak Sagar were completed for augmenting supplies in the Sarda Canal. The live storage capacity of the Sarda Sagar Stage II which includes that of Stage I is 461 m.cu.m. and of Nanak Sagar 173 m.cu.m. The Sarda River supplies fall to 141.5 cumecs, or even less during the winter when the demand for rabi irrigation is most keen. The Sarda Sagar reservoir was constructed to store extra supplies available in the Sarda Canal when the demand is slack and to utilize them for irrigation in times of keen demand.

The Nanak Sagar was constructed on the river Deoha for supplementing supplies in the Rohilkhand Canals. In addition, the Sarda Canal System was extended through the Pratapgarh Branch with 1,710 km. long channel and the Transkalyani Project, 1,293 km. long channels respectively. The total length of channels in the Sarda Canal System was thus increased from 9,505 km. to 13,680 km. The system is now designed to irrigate an area of about 0.81 million hectares.

Matatila Dam

Matatila Dam is a 36.58 m. high, 752.86 m. long masonry dam with a 6.44 km. long earthen embankments on the flanks, across the river Betwa

to impound 1,133 m.cu.m. of water. It is located 56 km. from Jhansi and about 16 km upstream of the Dhukwan Dam. After the construction of the Matatila Dam, about 383 km. of new channels have been constructed in the Betwa-Pahuj Doab. The total area irrigated annually by this project is 0.15 million hectares. The project has cost Rs. 124.60 million.

Ramganga River Project

The Ramganga Project envisages a 125.6 m. high and 625.8 m. long earth and rockfill dam across the Ramganga near Kalagarh in district Garhwal with a live storage capacity of 1,937 m.cu.m. Water from the reservoir will be released through a power house and picked up by a barrage at Hareoli about 24 km. downstream of the Ramganga Dam and diverted by a short feeder up to the River Kho. From the Kho it will be diverted by a barrage near Sherkot into a feeder channel of 141.5 cumecs which will flow into the Ganga near Sherpur. The total length of the feeder channel from Hareoli to Sherpur will be about 82 km. These supplies will be picked up from the Ganga at Narora and utilized on the Lower Ganga Canal System. The existing supplies to the Lower Ganga Canal will then be utilized in the Upper Ganga and Agra inter-lined inter-linked canal systems. On completion, the project will cost about Rs. 956 million and provide an additional annual irrigation of about 0.73 million hectares. The Ramganga power house will have an installed capacity of 198 megawatts. The drinking water supply for Delhi will be augmented by this project.

Gandak Canal Project

The project is a joint venture of Uttar Pradesh and Bihar. It comprises a barrage (built by the Bihar Government) across the Gandak in Nepal territory near Bhaisalotan about 17.7 km. north of the Uttar Pradesh-Nepal border. The State of Uttar Pradesh is responsible for the construction of the main Western Gandak Canal in Uttar Pradesh from M.11-6 to M.81-5-295 along with its distribution system. The head discharge of the Main Western Gandak Canal is 147.1 cumecs and the share of Uttar Pradesh is about 106.6 cumecs. The canal is being lined in the entire 113 km. reach in Uttar Pradesh to prevent loss by seepage and waterlogging through a possible rise of the water-table.

The project envisages to irrigate 0.29 million hectares annually in the districts of Deoria and Gorakhpur, including the area irrigated at present by the Naraini System. The length of the distribution system in Uttar Pradesh including the remodelling of the Naraini System will be about 2,415 km. The Uttar Pradesh portion of the project is estimated to cost Rs. 506.4 million.

Project Assist

In order to increase the intensity of irrigation in the command areas of the Sarda Canal System, which at present is only 19 per cent and to provide additional irrigation in the Ganga-Ghaghara doab, work on Project Assist has been started. The project envisages the diversion of about 368 cumecs of the normal flows of the Ghaghara and Sarda into different branches of the Sarda System through barrages on the two rivers and a feeder canal. The project is estimated to cost Rs. 996 million and will provide irrigation benefits to an area of 1.17 million hectares annually.

Tehri Dam

The Upper Ganga Canal suffers from an acute shortage of supplies for irrigation during the winter and summer months. This scarcity can be relieved only by constructing a storage reservoir upstream of the Ganga Canal Headworks. Western Uttar Pradcsh also suffers from a scarcity of power, and for relieving this power shortage, the generation of a large block of cheap hydroelectric power is necessary. These requirements of irrigation and power are proposed to be met by constructing a multipurpose project on the river Bhagirathi near Tehri town.

The Tehri Dam will be a rock-fill dam, about 237 m. high with a gross storage of about 3,330 m.cu.m. It will provide irrigation facilities to about 0.69 million hectares. It will have a power house with an installed capacity of 600 M.W.

The cost of the project is estimated roughly to be about Rs. 2,000 million out of which about Rs. 600 million will be debitable to irrigation benefits. The dam and its water spread will be wholly in Uttar Pradesh.

20.15 The net areas irrigated from different sources in 1968-69 are as follows:

Table 20.5

Area Irrigated—Source-wise

(Thousand hectares)

Source	Area irrigated
Government canals	2,351
Private canals	2
Tanks	357
Wells and tubewells	3,631
Other sources	231
Total:	6,562

The salient features of irrigation works irrigating over 4,000 hectares each, are given in Appendix 20.1.

Ayacut Development

20.16 There is no special organisation for ayacut development in the State. The coordination of this work is done by the Agriculture Production Commissioner. It is proposed to set up special committees of officers of various departments to take measures for ayacut development in areas which are to receive irrigation from major projects.

Most of Uttar Pradesh is a level plain and its problems of land-levelling and land-shaping are not serious. The farmers are allowed to do free cropping and the question of imposing cropping pattern does not arise. The farmers in large areas have been used to some sort of irrigation, and they readily take to high-yielding varieties of crops. Other problems of ayacut development such as construction of field channels; avoidance of field to field irrigation; provision of drainage; availability of finances are the same as in other parts of the country. These problems have been dealt with in Chapter VII of the First Volume. We trust that with the improvement in the organisational set up at the State level and in the district, speedy utilization of water-potential can be assured.

Drought Affected Areas

20.17 The southern plains of the State consisting of the whole of the district of Mirzapur, the Naughar area (particularly the hilly tracts) in tehsil Chandauli of the district of Varanasi, tehsil Meja and the Bara Pargana of tehsil Karchhana in the district of Allahabad and the Patna area lying in the tehsils of Karwai and tehsil Mau in the district of Banda constitute the low rainfall areas of the State.

The State witnessed two successive droughts during 1965-66 and 1966-67 which had a highly adverse effect on the economy. The drought of 1966-67 was so severe that the resultant scarcity almost reached the level of famine in certain areas. An estimated number of 1.87 million persons in district Allahabad; 0.43 million in district Banda; 1.6 million in district Varanasi; and 0.64 million in district Mirzapur were affected.

These areas of four districts are a part of the Vindhyan plateau and their terrain is rocky with a thin soil cover. The geological surveys have shown that there is no sub-terranial water. Ground water is available mostly in fissures and deep pockets. Sinking of tubewells or open wells is generally not feasible. Canals and minor tanks are the only possible source of irrigation there.

Historically, these areas have been prone to drought and scarcity and

suffer from extensive damage to crops and dearth of drinking water. The relief measures in these four districts cost Rs. 24.28 million during the recent drought years of 1965-66 to 1967-68. The State proposes to undertake a long-term programme to provide irrigation and drinking water to these areas.

During the Fourth Plan, the State proposes to intensify soil and water conservation measures. Irrigation facilities through canals, including lift canals and minor irrigation tanks are proposed to be extended to the maximum extent. Drought resistant varieties on the dry-farming pattern will be introduced to areas lacking in irrigation.

Future Development of Irrigation

20.18 With the availability of immense surface water potential, the scope for increasing the irrigation is considerable. The State Government has investigated a number of irrigation, multipurpose and canal-pumping projects. A list of important projects communicated to the Commission is given in Table 20.6.

A brief description of some of the more important schemes follows:

Pancheshwar Dam

The average irrigation in the lower reaches of the Sarda Canal System was only about 19 per cent of the C.C.A. as against 33 per cent on the entire canal system and 42 per cent in the upper reaches. The State Government has, therefore, proposed the construction of the Pancheshwar Dam 0.8 km. downstream of the confluence of the rivers Kali and Sarju on the border of Uttar Pradesh and Nepal and about 87 km. upstream of the Banbassa headworks of the Sarda Canal, to overcome shortage of water. It will also generate hydro-power. The Kali (Sarda) and its principal tributary the Sarju have at the border of India and Nepal a catchment of 12,190 sq.km. out of which 9,813 sq.km. lies in India and 2,377 sq.km. in Nepal. About one-eighth of this catchment is snow-fed. The dam will be about 277.36 m. above the deepest foundation level. A preliminary project report was prepared in the year 1967. The estimated cost roughly amounts to Rs. 3,300 million. The dam will impound 4,748 m.cu.m. of water (live storage).

Lakhwar Dam

It is proposed to construct a 176 m. high concrete dam across the river Yamuna at Lakhwar 21 km. upstream of Kalsi to relieve the shortage of water in the Eastern Yamuna Canal and add power generation capacity to

Table 20.6

Important Projects Investigated in Uttar Pradesh

Project	Name of river	Estimated cost (Rs. million)	Area proposed to be irrigated (hectares)
1	2	3	4
A. *Storage Schemes*			
Adwa Dam	Adwa	29.95	14,250
Kanhar Diversion scheme	Kanhar	176.00	—
Paisuni Dam	Paisuni	55.00	16,110
Fatehganj Dam	Khareli & Banganga	13.04	3,610
Baghain Dam	Baghain	49.50	32,800
Birma Dam	Birma	27.00	35,100
Urmil Dam	Urmil	34.40	16,600
Pancheshwar Dam	Kali	3,300.00	—
PurnaGiri	Sarda	1,030.00	—
Rajghat Dam	Betwa	320.00 (1st stage)	—
Kotli Bhel	Ganga	3,500.00	7,28,460
Ganga Barrage (Below Kanpur)	Ganga	160.00	—
Lakhwar Dam	Yamuna	500.00	1,56,000
Kishau	Tons	2,000.00	2,70,000
Khara Hydel Project	Yamuna	145.00	—
Greater Gangau Dam	Ken	—	81,000
Karnali	Ghagra	—	—
B. *Pumped Canal Schemes*			
Bhitaura	Ganga	12.90	39,600
Shringberpur	Ganga	15.00	29,300
Kishanpur	Yamuna	10.80	20,790
Ren	Yamuna	14.90	55,000
Sahurapur	Gomti	10.60	10,250
Son	Son	200.00	87,500
Salempur	Gomti	19.10	61,500

the Uttar Pradesh grid. The Lakhwar Dam will provide a gross storage of 888 m.cu.m. and provide irrigation facilities to 0.16 million hectares on the Eastern Yamuna Canal. The power potential of the project would initially be 100 MW but it would be increased to 150 MW on the completion of the proposed balancing reservoir at Biyasi. The estimated cost of the project is

Rs. 500 million out of which the share of irrigation benefits is Rs. 218 million.

Kishau Dam

In order to relieve the shortage of irrigation supplies on canal systems taking off from the Yamuna and generate hydroelectric energy, it is proposed to construct a high earth and rockfill dam (about 244 m. high) on the river Tons. The project is to have an installed capacity of about 450 MW. It will also provide irrigation for about 0.27 million hectares on the Yamuna Canal Systems in Uttar Pradesh and Haryana, besides providing flood protection to about 80,000 hectares along the Yamuna from Tajewala to Delhi. Delhi will also get additional supplies of the drinking water from this project. The project is expected to cost about Rs. 2,000 million.

Apart from new major, medium and minor irrigation works, there is considerable scope in the State for improvements to existing irrigation works by the lining of canals, better water management and change of crop patterns.

There is also considerable scope for expanding well and tubewell irrigation. A preliminary assessment by the State Government places this potential at 2.854 million hectares of irrigation.

The total irrigation potential of Uttar Pradesh has been estimated at 18 million hectares vide page 236-237 of Volume I of our Report.

Floods, Waterlogging and Drainage

20.19 Floods are a regular feature of Uttar Pradesh. A study of the damages by floods during the period 1951-69 showed that the area affected by floods in the State varies from 0.93 million hectares in a year of low flood to 4.098 million hectares in a year of high flood. The average area affected during floods of medium intensity is about 1.61 million hectares. In 1955, it was estimated that 19 per cent of the population was affected by floods and the loss suffered was about Rs. 400 million. The maximum damage to crops, houses and public utilities during the period 1953-69, was Rs. 616.06 million and the average was Rs. 220.17 million. The areas most affected by floods are Bulandshahr in the west and Basti, Bahraich and Ballia in the east.

The floods in Uttar Pradesh are caused by the Ganga, Yamuna, Ghaghara, Rapti, Ramganga and Sarda. The flat nature of the country and want of drainage channels are mostly responsible for the intensity of floods. The nature of the problem varies from region to region. In the central region, the main rivers are the Ganga, Yamuna, Sarda and Ghaghara and their tributaries like the Gomti, Sai and Kalyani, which swell during the

rainy season and overflow their banks. Besides inundation, damage is caused by the erosion of river banks.

The main causes of floods in the eastern districts are: (i) high intensity of rainfall, (ii) poor land slopes, (iii) high sub-soil water-level, (iv) accumulation of detritus in river beds, and (v) a number of depressions which are difficult to drain off.

Prior to 1954, very few flood works had been constructed, the important ones being (i) the embankment between the Delhi Railway bridge and the Okhla Weir along the river Yamuna, (ii) the Maloni and Roberts bunds in the district of Gorakhpur along the Rapti bank for the protection of the town of Gorakhpur and adjoining areas and (iii) an embankment on the left bank of the river Tons to protect the town of Azamgarh.

In the first two plans an expenditure of Rs. 107.6 million was incurred on flood control works which benefited an area of 0.454 million hectares. Out of this sum, Rs. 34.9 million was incurred on marginal embankments, Rs. 47.5 million on raising marooned villages, Rs. 13.1 million on the protection of towns and Rs. 6.6 million on drainage improvement works. The drainage improvement works were also undertaken as part of the Minor Irrigation Works on which Rs. 18.5 million were spent benefiting an additional area of 40,000 hectares. In the Third Plan an amount of Rs. 62.6 million was spent on flood control and drainage improvement schemes benefiting an area of 56,000 hectares. The main items of work were marginal embankments, protection of towns and drainage improvement works. Some of the important marginal bunds constructed in east Uttar Pradesh are the Ballia-Baria bund along the Gandak, the Mohala Garhwal Bohra Bahrauli Bund and the Paraspur Dharauma Bund along the left bank of the Sarju.

The Government of India asked the States to prepare master plans for flood control and drainage improvement. Uttar Pradesh prepared a master plan of works costing Rs. 2,280 million. It was estimated that on the implementation of the plan, 83 per cent of the flood problem would be controlled.

The plan envisages the protection of 2.79 million hectares of cultivated area, the raising of the levels of 8,700 villages and protection to about 168 towns.

The broad categories of works proposed to be undertaken are:

(i) Marginal embankments to check inundation of the hinterland.
(ii) Protection to towns.
(iii) Increase in waterways in masonry works, and
(iv) Anti-erosion works.

By 1966 about 0.49 million hectares are reported to have been given protection against floods.

Reliable data about the extent of waterlogging are not available. On a rough basis, the State has estimated that waterlogging conditions exist in

an area of about 0.81 million hectares. A record of water-table fluctuations is maintained by observing water-levels in wells in the month of May in the hot season and in the months of September and October in the post monsoon season. Recently, the State has created a ground water cell to carry out systematic studies in different regions of the State. The cell has commenced its work only recently. Generally there is a rise in water-table near the heavy embanked canals where substantial seepage takes place. In order to reduce the waterlogging, open seepage drains are excavated alongside the canals at the toe of the embankments. Provision for surface drains in project areas is made in the project estimates. So far, no sub-surface drainage system or tubewells have been tried to give relief against waterlogging.

The recent master plan for improving drainage consists of the following items:

	Quantity	*Cost*	*Area benefited*
		Rs. million	million hectares
1. Increasing waterways of masonry works	182 nos.	76.7	1.04
2. Remodelling existing drains & excavating new drains	6,098 km.	82.6	3.14
Total		159.3	4.18

This plan covers only priority works but due to paucity of funds it would not be possible to take up construction of other works in the near future.

Financial Aspects, Water Rates and Betterment Levy

Water Rates

20.20 The existing irrigation tariff has four different schedules for surface irrigation. These schedules apply to different categories and qualities of supplies. Schedule I which is the highest applies to old established canals with assured supplies. The other schedules apply to canals on which supplies are less assured or are precarious.

The Schedule I rates are as below:

Crop	*Flow*	*Lift*
	Rs. per acre	Rs. per acre
Sugarcane	40.00	20.00
Rice	14.00	7.00
Cotton	4.50	2.50

Crop	*Flow* Rs. per acre	*Lift* Rs. per acre
Wheat	12.00	6.00
Other rabi crops	9.00	4.50
Other kharif crops	7.00	3.50
Fodder crops	3.00	1.50

These rates have been recently increased by 25 per cent.

Formerly there were two water rates for water supply from State tubewells. The first provided a fixed charge of Rs. 20/- per acre and Re. 1/- for every 24,000 gallons of water used and the second with no fixed charge but Re. 1/- for 12,000 gallons of water.

The newly revised rates now provide for only one system of assessment namely a Re. 1/- for 8,000 gallons for all State tubewells except those of a higher capacity of 3 and 5 cusecs to which the following rates apply:

(i) Fixed charge of Rs. 20 per acre of irrigated area.

(ii) Watering charge of Rs. 8 per acre per watering for rabi and summer crops and Rs. 10 per acre per watering for paddy and sugarcane.

We were given to understand that the State is considering proposals for further enhancing water rates.

Betterment Levy

20.21 No act for the levy of betterment charges has been passed in the State. No betterment levy has been imposed so far or is proposed for the present.

Administration, Irrigation Management and Research

20.22 The Engineer-in-Chief, Irrigation Department, is in overall charge of all works in the Department, which include the construction of major, medium and State tubewells. Ramganga, Yamuna and Sarda Assist Projects have separate Additional Chief Engineers in exclusive charge of these projects. The other Additional Chief Engineers look after both construction and maintenance on a zonal basis. In addition, there is a Director of Tubewells and a Director of Lift Irrigation both exercising powers of a Chief Engineer.

The investigation and planning of major and medium irrigation works is being looked after by three Investigation and Planning Circles, each under a Superintending Engineer. There is no separate Chief Engineer for investigation and planning. The design of major and medium works is looked after by the Central Design Directorate of the Irrigation Department.

The Minor Irrigation Organisation of the Agriculture Department extends help to farmers in boring of private tubewells and open wells.

In areas where intensive agricultural programme including those covering high-yielding varieties are adopted, the coordination among senior officers of irrigation, revenue, agriculture and other concerned departments is effected by State level and district level committees.

Coordination in the working of different departments concerned with agriculture production, is effected at the district level by the District Magistrate and at the State level by the Agriculture Production Commissioner.

20.23 The Irrigation Research Station at Roorkee carries out the work of analysing materials, like soil and cement concrete not only for the Irrigation Department but also for other departments. It conducts studies on hydraulic structures, designs for training rivers, behaviour of rivers under different conditions, control of rivers and ground water. The station maintains an experimental farm at Dhanauri, where experiments on the water requirements of wheat and rice are made under a centrally sponsored scheme. It is now proposed to include work on water management and salinity under a scheme sponsored by the Indian Council of Agricultural Research.

The State Agriculture Department also maintains a number of agricultural research stations, where research on the water requirement of crops and allied aspects of water management is carried out. These stations are located at Jhansi, Kanpur, Lucknow, Pantnagar, Roorkee, Shahjahanpur and Varanasi.

Inter-State Problems

20.24 The State proposes to construct an earth and rockfill dam about 244 m. on the river Tons. Known as the Kishau Dam, it would be an inter-State project. Part of the catchment of the project lies in Himachal Pradesh. Its irrigation benefits are expected to be shared by Uttar Pradesh, Haryana and Rajasthan while power benefits may be shared by Himachal Pradesh, Punjab, Haryana and Uttar Pradesh.

Several rivers in the southern region of Uttar Pradesh originate in Madhya Pradesh. Uttar Pradesh has investigated a number of schemes on these rivers. Agreement with Madhya Pradesh is necessary to take up the execution of these schemes. Some discussions have taken place but no final decisions have been arrived at. The names of the schemes involving inter-State aspects with Madhya Pradesh are shown below:

1. Panchanad Dam
2. Rajghat-Dhurwara Dam
3. Piprai Dam
4. Kurra Dam
5. Kurar Dam
6. Greater Gangau Dam

7. Urmil Dam
8. Baghain Dam
9. Fatehganj Dam
10. Paisuni Dam
11. Kanhar Dam
12. Bansagar Dam

Tours, Inspections and Observations

20.25 Uttar Pradesh being close to the Commission's headquarters at New Delhi, the visits to the State were made in several spells of short durations. The Commission, as a whole, toured different parts of the State in two laps, once in April-May and a second time in December, 1970. The areas visited during the first lap were roundabout Lucknow, i.e., the Dalmau Pumping Scheme in Rai Bareli district and some channels of the Sarda Canal System. The second visit covered the eastern and southern portions of the State including the irrigation systems of the Karamnasa river (Moosakhand dam), tubewells in Ghazipur district, the Dohrighat and Raunahi Pumped Canal Schemes on the Ghaghara, the Bhainsalotan barrage, the Gandak Canal System and some distributaries of the Sarda Canal System in the east. In the south, we visited the Barwa Dam, and some medium schemes in Banda district, the Ken Canal System and the Fatehpur branch of the Lower Ganga Canal System.

20.26 Among the projects or areas visited by one or more members of the Commission are the Agra Canal System, the lower portions of the Eastern Yamuna Canal, the headworks of the Eastern and Western Yamuna Canals at Tajewala, the Doon Canal System, the Upper Ganga and Sarda Canal headworks, the Sarda Sagar Reservoir, the flood protection works of the Balia, Roorkee Engineering University and Irrigation Research Station at Roorkee.

20.27 During the first visit, the Commission had the benefit of discussions with the then Chief Minister Chaudhary Charan Singh and his colleagues. Later, discussions were held with the Chief Minister Shri Kamalapati Tripathi at New Delhi. During our tours discussions were held with farmers, District Officers, M.L.As. and M.Ps. We also held discussions with the Minister for Irrigation and the Officers of Irrigation, Agriculture and Minor Irrigation Departments of the State and the Chairman and Officers of the State Electricity Board. The Chief Minister and the Minister for Irrigation with the Chief Secretary, the Secretary Irrig tion and the Engineer-in-Chief of Irrigation Department visited the headquarters of the Commission in December, 1971 and gave the Commission an opportunity to exchange ideas on important matters concerning irrigation development in the State.

Surface Irrigation Systems

20.28 Most of the irrigation works in Uttar Pradesh are run-of-the-river diversion schemes depending on available supplies in the rivers. They are, therefore, unable to provide timely irrigation for high-yielding crops. Constructed as protection works against the failure of rainfall, they are inadequate to meet the irrigation requirements of rabi and hot weather crops from the month of November to May, when river supplies are low. The problems of inadequacy in the Sarda Canal System has been discussed in detail in Volume I Chapter IX—Improvements to Existing Irrigation Systems. The State Government is aware of these limitations and has taken up the construction of some major and medium schemes to supplement canal supplies. With the proper reservoir support, not only can the existing shortages be overcome but irrigation benefits can be extended to new areas.

Conservation of Monsoon Water

20.29 A fine example of conserving monsoon flows is the Karamnasa complex of storages and pick-up weirs, which have, more or less, completely harnessed the entire flows of the river. We would recommend that similar schemes for the conservation of water of other streams should be investigated especially those in backward areas.

Inter-basin Transfers of Water

20.30 The State possesses some fine inter-basin links to transfer water from one major river basin to another. About a century back, the Ganga and the Yamuna were interlinked through the river Hindon. The Ramganga Project under construction will now connect the Ramganga and the Ganga. The Sarda Assist Project will divert water from the river Ghaghara into the Sarda command.

Further possibilities of inter-basin transfers through gravity flow, lift or lift-cum-storage need to be investigated. Such transfers can particularly benefit the southern dry region of the State. In this connection, a reference is invited to Chapter X of Volume I dealing with the Perspective of Irrigation Development.

River Pumping Schemes

20.31 The major river pumping schemes in the State are:

(i) The Dalmau Scheme from the Ganga in district Rai Bareli (11.9 cumecs).

(ii) The Dohrighat Scheme from the Ghaghra in Azamgarh district (17 cumecs).
(iii) The Raunahi Scheme from the Ghaghra in Azamgarh district (8.5 cumecs).
(iv) The Zamania Scheme from the Ganga in Varanasi district (8.5 cumecs).

We were given to understand that the capacity of the first three schemes would be increased to 23.8 cumecs, 20.4 cumecs and 11.3 cumecs respectively. There are also a large number of smaller river pumping schemes.

20.32 The Dohrighat and Raunahi pumping schemes were built on permanent well-foundations and some newer ones like Dalmau have their pumping sets fitted on barges with elastic deliveries. The experiment of mounting pumps on barges has been successful not only for smaller schemes but even for larger ones.

Most of the lift schemes have independent commands while some like the Dalmau Scheme supplement existing supplies from canals.

20.33 We feel that there is good scope in the State for the construction of more lift irrigation schemes. These schemes would be particularly beneficial in providing irrigation to tracts with deficient rainfall and lacking in ground water.

20.34 We would, however, like to sound a word of caution against the construction of pumped canals in areas which have copious rainfall and/or an abundance of ground water resources. A case in point is the proposal to undertake another pumped canal from the river Ghaghra to augment the existing supplies in Dohrighat Canal for stabilising existing irrigation and providing additional irrigation in Azamgarh and Balia districts. The region has assured and adequate rainfall and the water-table is within 4.6 m to 6.1 m of the surface during the hot season. It is higher during the monsoons. In our opinion, it would be worth considering whether sub-soil water could not be used for irrigation instead of pumping river water into the soil which may enhance the risk of waterlogging.

20.35 The construction of larger pumped canal is obviously beyond the capacity of individuals. However, efforts should be made to organise co-operatives to construct smaller pumped canals. In such cases, the State Government must provide free technical assistance and liberal finance as is being done in Maharashtra.

20.36 Water from pumped canals is much more costly than that from gravity canals. It is, therefore, necessary that the commands under pumped

canals should set up a sound system of water management to economise in water use. In our opinion, pumped canals should ordinarily be lined and sprinkler irrigation from their waters encouraged. We would also like to emphasise the importance of the expeditious utilisation of the potential of the pumped canals. We think it would greatly accelerate the utilisation if field channels in the commands of pumped canals are constructed by the project authorities.

Ground Water Development

20.37 The State has the richest ground water resources in the country. These resources have been put to good use through State tubewells which numbered 10,173 in March, 1971. These tubewells extract as much as 425 cumecs of water from the sub-soil. There are also very large numbers of private shallow tubewells and open wells fitted with pumping sets.

20.38 So far no systematic sub-basinwise studies of ground water resources have been done in the State and the ground water development has been sporadic. We were glad to learn that an organisation has recently been set up for this purpose and it is now assessing the potentialities of ground water region-wise.

20.39 Most State tubewells in the State do not overlap canal commands, but the intensity of private tubewells in canal commands is quite high. These tubewells help to cover the deficiencies in the canal deliveries. We were told that recently a State Tubewell Project had been initiated to supplement canal supplies in the tail reaches of the Eastern Yamuna Canal where surface supplies are grossly inadequate.

20.40 The State is also experimenting with higher discharge tubewells. We visited one such tubewell in the village of Suneswarpat in district Ghazipur. Its location near the Ganga enables it to deliver seven cusecs at a depression of only 4.6 to 6.1 m.

The possibilities, economics and comparative benefits of larger tubewells have yet to be studied. At present, it is not possible for us to express an opinion on their economics. We would like the State Government to initiate studies in the matter.

20.41 The command of the Suneswarpat tubewell is fixed at 405 hectares, but it has not adequate length of field channels to irrigate the entire area. The reasons given to us were lack of finances and difficulties in land acquisition. As against the full discharge of 7 cusecs, the discharge of this tubewell is at present limited to only 2.8 cusecs. The annual expenditure

on the tubewell on an average comes to Rs. 59,500/-, (Rs. 27,000/- electricity, Rs. 1,300/- salaries, about Rs. 1,000/- maintenance and Rs. 30,000/- depreciation and interest at 10 per cent). The revenue at present is only Rs. 9,000/-. There is thus a loss of about Rs. 50,000/- per year. We were told that if conditions are created to utilise its full potential, the revenue can appreciate sufficiently to discharge the annual expenditure. We trust that the State Government would take immediate steps to fully utilise the capacity of the tubewell.

20.42 We also looked into the overall financial position of the State tubewells. It appears they are showing a loss of almost Rs. 60 million per annum. Tubewells in the western districts running for 5,000 to 6,000 hours per year break almost even on their expenditure and revenue but those in the eastern districts running only 2,000 to 3,000 hours per annum suffer heavy losses. Their potential has not been fully utilised though it is more than ten years since they were completed.

20.43 It was mentioned to us that the supply of electric energy to State tubewells is heavily rostered during periods of keen demand. This not only affects their revenue adversely but causes frustration to the cultivators at crucial time in the crop growth.

20.44 We also feel that an adequate extension service should be organised for State tubewell commands to develop high-yielding varieties of crops. This is more necessary now as tubewell commands are being progressively reduced to increase water supplies to high-yielding crops. This would also improve the working hours.

20.45 The development of ground water in area of plentiful rainfall with high sub-surface water-level should, in our opinion, be left to farmers. However, to prevent an indiscriminate sinking of tubewells, and over-exploitation of ground water, the construction of deep tubewells should be regulated by law. We have in view the districts of Ghazipur, Azamgarh, Ballia, Bahraich, Basti, Gorakhpur, Gonda, Deoria which would need special attention. It should be borne in mind that the State tubewells in these areas are being inadequately utilised and any further increase in their numbers would cause additional loss to the exchequer.

20.46 The shallow tubewells are cheap to sink and easy to manage. A tubewell with a capacity of about 10,000 gallons per hour drilled to a depth of 30 to 40 metres would roughly cost Rs. 8,000/- to Rs. 10,000/- which is within the capacity of bigger farmers. Smaller farmers should be given encouragement to sink joint or cooperative tubewells. They should be

helped with free technical advice and a low-interest bearing loans and/or free grants.

20.47 The Minor Irrigation Division of the Agricultural Department may also undertake the construction of shallow tubewells and installing of pumping sets on open wells for farmers. This will ensure that whatever loans or subsidy are being given would be utilised for the purpose for which they were advanced.

Integrated Development and Conjunctive Use of Surface and Ground Waters

20.48 The concept of making conjunctive use of surface and ground waters does not appear to have caught on in the State. In the three major surface canal schemes—the Gandak, the Project Assist and the Ramganga—there is no plan to make conjunctive use of the surface and ground supplies. The Gandak and Project Assist schemes will irrigate tracts where the water-table is high and the release of massive surface supplies into the area may raise the water-level higher and cause waterlogging.

20.49 We were informed that the effects of these projects on the ground water regimes are being studied. Perhaps, it is not yet too late to re-schedule canal supplies and plan for the conjunctive use of both surface and ground water.

Similar studies, in our opinion, should be instituted in the command areas of older schemes like the Ganga and Sarda Canals to find out the possibilities of supplementing surface supplies with ground water.

Ayacut Development

20.50 The State is in the happy position of having flat and even areas which do not need land shaping or levelling. In the older canal systems there already exists an extensive network of field channels. In the newer systems too the cultivators are not averse to constructing field channels.

But delays in the construction of field channels are not infrequent. Even the amendment of Northern India Canal & Drainage Act conferring upon the department liberal powers to construct field channels has not fully solved the problem.

20.51 Field to field irrigation is practised in some projects particularly in the eastern districts. We are of opinion that the construction of field channels should be given high priority in the commands of projects where field to field irrigation is being practised. We think that if suitable subsidies

are given for the construction of cross-culverts on village roads, losses of water caused by breaches in field channels could be avoided.

20.52 The Agriculture Department of the State is not at present associated with the formulation of irrigation projects in the initial stages. The irrigation department determines the cropping pattern and the concurrence of the agriculture department is sought after the project's formulation. A suitable cropping pattern can be devised only after proper soil surveys, and we are of opinion that the agriculture department, which is responsible for soil surveys, should be associated with the projects from the very beginning. Our views in this regard are contained in Chapter V of the First Volume "Planned Development of Water Resources" (para 4.25 page 91).

20.53 The Agra Canal is essentially a rabi canal and does not give any irrigation during kharif. The nature of the weir at Okhla and the absence of demand for the Kharif irrigation may be the reasons for not running the canal during the monsoons. We would like the State Government to make studies for utilizing the potential of this canal to irrigate kharif crops.

20.54 There are tracts of culturable usar and banjar lands in the districts of Aligarh, Eath, Mainpuri, Farukhabad and Kanpur etc., which, if reclaimed, may produce rice. With copious supplies in canals during the monsoon, efforts should be made to reclaim these areas for raising a paddy crop.

We feel that agricultural research, extension services, demonstration farms and demonstrations on cultivators' fields should be increasingly organised so as to keep pace with the development of irrigation.

Inter-State Problems

20.55 Uttar Pradesh is jointly participating in the development of irrigation with Haryana in the Yamuna valley and with Madhya Pradesh on the Betwa, Dhasan, Ken etc.

In the Yamuna valley, the problem of providing suitable barrages at Tajewala for the Eastern Yamuna Canal and at Okhla for the Agra and the Gurgaon Canals has been under discussion between the two States for some time, but it has not been settled yet. As a consequence, the Eastern Yamuna Canal which commands some of the most fertile tracts of Uttar Pradesh continues to suffer from inadequate supplies not only during rabi but also during kharif.

We trust that the outstanding problems between Uttar Pradesh and

Haryana and Uttar Pradesh and Madhya Pradesh will be settled to the mutual advantage of both.

Flood Problems in the State

20.56 We visited some flood affected areas and the protection works in Ballia district along the Ganga and the Ghaghra.

Flood levees along big rivers are costly to construct and maintain. We are glad the State Government has taken action to provide protection against floods to cultivated areas and habitation by constructing flood embankments.

Our suggestions in this connection are:

(i) A long range plan for constructing protection works should be formulated; and

(ii) Imposition of a suitable betterment levy on agriculture lands which get protected.

Our comments on this matter in para 13.33 on page 319 of the First Volume are relevant.

Irrigation Tariffs

20.57 In addition to the financial loss of about Rs. 60 million on State tubewells mentioned earlier, the State is incurring a loss of about Rs. 50 million per annum on canals. With the further development of irrigation, these losses would increase if the present water rates are allowed to continue. We are glad that the State is seized of the problem. During our discussions with the Chief Minister in December last, we were informed that the proposals to revise irrigation rates are under way.

We also learnt that though the supplies from the Karamanasa complex are as assured as those from flow canals to which Schedule I applies, yet only the Schedule II water rates are charged in this project. There is obvious justification for the Irrigation Schedule to be revised.

The State has so far not enacted any statute for the imposition of a betterment levy. In this connection we would invite a reference to Chapter XI of Volume I—Economics and Financing of Irrigation Works—and suggest that action may be initiated for this purpose.

Administration

20.58 At present three Circles are looking after the work of investigations and planning in the State. Considering the size of the State and the magnitude of work involved in field observations and in planning and preparing river valley projects, it appears that this organisation needs to be

strengthened. We are of opinion that there should be a separate Chief Engineer for this work to coordinate activities relating to the formulation of schemes from surface and ground water resources.

20.59 Lately the Department has made heavy recruitment to the cadres of Assistant Engineers, Overseers, Supervisors and other field and office staff. The new entrants would proceed with their task with greater confidence, if they are given some initial training in construction, management and agriculture practices and office work. The different categories of staff would also need refresher courses to improve their efficiency. We understand that the State Government has made a start with a training centre for new entrants at Lucknow. We trust that as time passes the training facilities would be provided to each region. In this connection, a reference, is invited to Chapter XVII Volume I, on Research, Education and Training.

20.60 The Northern India Canal & Drainage Act of 1873 is applicable to all irrigation works in the State. It is a comprehensive statute covering all aspects of irrigation. Haryana and Punjab, which are governed by the same statute, have amended it to meet the new needs of irrigation development. In Uttar Pradesh, the Act has been amended only to provide for construction of field channels. A review of this statute appears to be called for so that it becomes responsive to the changed conditions.

CHAPTER XXI

WEST BENGAL

After Partition in 1947 the State of West Bengal came into being. It was left with a little less than two-fifths of the territory of the undivided Bengal. In 1950, the Princely State of Cooch Behar, in 1954 the French settlement of Chandernagore and in 1956 on the re-organisation of the State the Purulia sub-division of Manbhum district and a portion of the Kishenganj sub-division of Purnea district of Bihar were incorporated in the new State. The State has at present a geographical area of 87,676 sq.km. The Tropic of Cancer passes through the middle of West Bengal. The State has common borders with Nepal, Bhutan and Sikkim on the north, Assam and Bangladesh on the east, Bihar on the west and Orissa on the south-west. It is bound in the south by the Bay of Bengal.

According to the 1971 census the population of West Bengal was 44.44 millions living in 137 towns and 41,951 villages. The density of population in the State was 507—next only to Kerala (548)—against the average of 182 per sq.km. for India.

West Bengal has an extensive network of rivers, canals and innumerable tanks and lakes. In the northern part of the State, the important rivers are the Teesta, the Torsa, the Jaldhaka and the Rangeet which flow in Darjeeling and Jalpaiguri districts. The river Mahananda rises in the hills of Darjeeling and flowing southwards, joins the Ganga. The Bhagirathi-Hooghly a branch of the Ganga, flows through the centre of the State. The city of Calcutta is situated on the Hooghly—about 120 km inland from the sea. The rivers Mayurakshi, Ajoy, Damodar and Kangsabati rise in Chhotanagpur hills of Bihar and flow through the western part of West Bengal to join the Bhagirathi-Hooghly. The other important rivers are the Subarnarekha, the Rupnarayan, the Haldi, the Dwarakeswar, the Mandeswari, the Dwaraka and the Brahmani.

21.2 Prior to Partition, the importance of irrigation in Bengal was not keenly felt, as the undivided Bengal could grow rain-fed crops to feed its population in normal years.

On the partition of the country, extensive areas of fertile agricultural land went to Pakistan, and the truncated State of West Bengal had to depend on

other States of India to meet its food requirements. The Government has taken up several major and medium projects during the Plan period. The most important of these are:

The D.V.C. & improvement and extension schemes	364,300 hectares
The Mayurakshi Project	246,870 hectares
The Kangsabati Project	385,000 hectares

The first two projects are practically completed while the Kangsabati Project is in progress. The net irrigated area in West Bengal during 1964-65 stood at 1.478 million hectares. The details (source-wise) are:

Canals	0.941 million hectares
Tanks	0.334 ,, ,,
Wells	0.016 ,, ,,
Other sources	0.187 ,, ,,
Total	1.478 million hectares

Physiography

21.3 Except for the Himalayan foothills, and the Chhotanagpur Plateau protruding into its western fringe, West Bengal is a flat plain criss-crossed with rivers. Distinct physiographic, climatic and other characteristics divide the State broadly into two natural divisions—the Himalayan region with its piedmont plain in the north, comprising three districts of Jalpaiguri, Cooch Behar and Darjeeling, and the Gangetic plains, to the south, extending over the rest of the State.

Situated in the foot-hills of the Himalayas, the northern-most district of Darjeeling has a maximum elevation of about 3,700 metres above the sea level. The other two districts viz. Cooch Behar and Jalpaiguri (except the northern portion) consist mostly of low plains. A number of swift-flowing perennial rivers like the Teesta, the Torsa, the Jaldhaka and the Rangeet and their tributaries flow through this region. These rivers are often in spate and cause widespread damage. The hydro-potential of these rivers is considerable.

The plains in the south have been built up by the Bhagirathi and its tributaries, like the Mayurakshi, the Damodar, the Kangsabati and the Rupnarayan. The Bhagirathi flows into the State in a south-easterly direction between the borders of Malda and Murshidabad districts. The river separates the three Himalayan districts and the adjoining plain of West Dinajpur and Malda districts from the rest of the State. The deltaic area, commonly

known as the Sunderbans, has been built up primarily by the silt carried down by the Bhagirathi and its many branches and the silt brought in by tides. The region is criss-crossed with tidal creeks and channels.

Soils

21.4 There are four principal types of soil in West Bengal namely, (a) brown podsolic, (b) red laterite, (c) alluvial soil and (d) mangrove soil.

The brown podsolic soil occurs in the sub-Himalayan districts of Darjeeling, Jalpaiguri and Cooch Behar. The capacity of the soil to retain moisture is very poor as its structure is porous. It is suitable for tea plantation.

Red laterite soil is found in a strip running through the south-western districts of Midnapore, Bankura, Burdwan, Birbhum and Purulia. It is deficient in lime and phosphorus. Due to its porosity, the water-holding capacity of the soil is also not good. With proper irrigation and use of fertilisers, it can raise good crops.

The plains of the north and south fall within the Gangetic alluvial tract, comprising the major part of the State. The soil is very fertile and is suitable for growing a variety of crops.

Mangrove soil occurs in the estuarine swamps of the south 24-Parganas and Midnapore districts. It has a high saline content and is of very limited use for cultivation, though substantial areas have been reclaimed and made fit for cultivation by leaching out salts.

Climate and Rainfall

21.5 Except for the Himalayan region, West Bengal has generally a tropical climate. The temperature in the Himalayan district ranges from below freezing point in winter to over 27°C in summer. The summer temperature in the plains ranges from 27°C to 43°C. However, due to the proximity of the sea which exerts a modifying effect on temperatures, there are no extremes. The winter is pleasant and cool and lasts from November to February.

The average rainfall in the State is about 1,750 mm of which 1,250 mm occurs during the monsoon months from June to September. There are, however, wide regional variations. The Himalayan region receives the heaviest rainfall, ranging from 2,500 mm to over 5,000 mm while the plains districts receive on an average 1,125 mm to 1,875 mm. Among the districts in the plains, Bankura receives the lowest rainfall (1,175 mm) and Jalpaiguri the highest (3,900 mm).

With such wide variations in the intensity of rainfall, the State frequently suffers from both drought and floods. Drought is more often caused by the

lack of adequate and timely rain than by the complete failure of the rains. Floods do cause damage to crops but they are not an unmitigated evil, since they enrich the land by depositing layers of silt.

Land Use and Cropping Pattern

21.6 Table 21.1 shows land utilisation statistics in the State during 1964-65; the latest year for which it is available

Table 21.1*

Land Use Pattern—West Bengal

Classification	Area (thousand hectares)	Percentage of reporting area
1	2	3
Geographical area	8,785	—
Reporting area	8,852	100.0
Forests	1,108	12.5
Land not available for cultivation	1,288	14.5
Other uncultivated land excluding fallow land	608	6.9
Fallow land	279	3.1
Net sown area	5,569	63.0
Total cropped area	6,653	75.0
Area sown more than once	1,084	12.0
Net irrigated area	1,478	16.7
Gross irrigated area	1,499	17.0
Area irrigated more than once	21	0.3
Percentage of net irrigated area to net area sown		26.5
Percentage of gross irrigated area to gross cultivated area		22.5

**Source:* Union Ministry of Food & Agricultural, E & S Directorate.

The landuse pattern of West Bengal shows that 63 per cent of the area in the State is under cultivation against the all-India figure of 45 per cent. There is not much scope for bringing more land under the plough. The only way to increase agricultural output appears to be by the intensive cultivation, double cropping and obtaining higher yields per hectare. At present only 19.5 per cent of the net sown area and only 1.5 per cent of the irrigated area are being double cropped. There is thus considerable scope for in-

creasing double cropped areas under both irrigated and unirrigated conditions.

The principal reason for the low crop intensity in the State is the paucity of irrigation facilities during the non-monsoon months. The land is generally left fallow during the winter months, though with irrigation it could be utilised for growing a second crop. For increasing agricultural production through multiple cropping, the provision of perennial irrigation facilities is essential.

21.7 Agriculture in West Bengal, as in other parts of India, is food-oriented. In 1964-65, nearly 88 per cent of the total area sown, that is, 5.84 million hectares out of 6.653 million was under food crops. Rice was by far the most important food crop, grown over more than 70 per cent of the cropped area. Two of the State's major cash crops, jute and tea were grown over 6.8 per cent and 1.3 per cent of the cropped area. Table 21.2 shows the area under different principal crops during 1964-65

Table 21.2

Principal Crops Grown in West Bengal

Crop	Area (thousand hectares)	Percentage to total cropped area
1	2	3
Rice	4,671	70.3
Wheat, maize and other cereals	148	2.2
Total cereals and millets	4,819	72.5
Gram	152	2.3
Arhar and other pulses	635	9.6
Total pulses	787	11.9
Total foodgrains	5,606	84.4
Sugarcane and others	44	0.5
Condiments and spices	14	0.2
Fruits and vegetables	172	2.6
Other food crops	4	0.1
Total food crops	5,840	87.8
Oilseeds (Rape, mustard, linseed)	156	2.3
Jute	456	6.8
Mesta, sunhemp and others	92	1.4
Tea	85	1.3
Other plantation crops	18	0.3
Other crops	6	0.1
Total non-food crops	813	12.2
Total cropped area	6,653	100.0

Surface Water Resources

21.8 The principal rivers of West Bengal can be broadly grouped into four systems:

(i) The northern system consists of a number of swift flowing perennial rivers like the Teesta, Torsa, Jaldhaka and Rangeet, and their tributaries flowing in districts of Jalpaiguri and Darjeeling. The Mahananda originates from the hills of Darjeeling, and after flowing in the north Bihar and Malda districts of West Bengal, joins the Ganga. All these rivers are subject to flash floods.

(ii) The central system is dominated by the Bhagirathi-Hooghly, an arm of the Ganga. The river enters the State below Farakka and flows practically north-south across West Bengal till it finally falls into the Bay of Bengal.

(iii) The western system comprising the Mayurakshi, Ajoy, Damodar, Kangsabati and Dwaraka originates in the Chhotanagpur plateau. These rivers flow eastwards across districts of Birbhum, Burdwan, Purulia, Bankura, and Midnapore, to join the Bhagirathi.

(iv) The fourth system consists of the tidal and estuarine rivers of Sunderbans. Apart from major rivers like the Hooghly, Ichamati, Kalinadi and Rajmangal, there are several channels passing through the area like the Saptamukhi, Thakuran, Matla, Gosaba and others.

Except for the Ganga (Bhagirathi-Hooghly), the Teesta and some of their tributaries, which are snow-fed, the remaining rivers are rain-fed. The highest flow in these rivers is during the monsoon and it dwindles in non-monsoon months. Table 21.3 shows the percentage of yields during different parts of the year in some of the rivers:

Table 21.3

Seasonal & Annual Flows of Rivers of West Bengal

River	Total flow (m.cu.m.)	Percentage of yield			Years for which the average has been worked out
		June-Sept.	Oct.-Dec.	Jan.-May.	
1	2	3	4	5	6
Mayurakshi at Messanjore	1,032	88	9	3	1949-53
Kangsabati at Ambikapur	1,653	82	17	1	1953-61
Damodar at Rhondia	8,102	67	23	10	1956-57
Teesta at Teesta Bazar	17,658	63	20	17	1956-58 1960-63
Torsa at Ghugumari	8,692	70	16	14	1956-63

Source: State Replies to Irrigation Commission.

Hydrological Observations

21.9 In West Bengal, there is no separate organisation for the assessment of surface water resources. This work has been done for a few river basins connected with river valley projects such as the Damodar, Mayurakshi, Kangsabati in the south and the Teesta, Torsa etc. in the north. The River Research Institute took up the hydrological observations of the Damodar, Mayurakshi and Kangsabati rivers during 1945-49, 1946-53 and 1952 respectively. The work on the Damodar system was handed over to the Damodar Valley Corporation, when it was formed in 1949. The work on the Mayurakshi was stopped in 1954 after the completion of the Mayurakshi dam. The collection of hydrological and hydraulic data for the north Bengal rivers was started in 1946, under the North Bengal Irrigation Circle with the assistance of the River Research Institute for the Teesta and from the year 1954 more systematically for the Teesta, Torsa etc.

Ground Water Resources

21.10 The Exploratory Tubewell Organisation has completed explorations in West Bengal over an area of nearly 23,500 sq. km. It has indicated the possibility of drilling 4,000 deep tubewells in an area of 14,000 sq. km. with an expected discharge per tubewell of 40,000 gallons per hour.

A recent survey by the Geological Survey has disclosed that shallow tubewells can be sunk successfully in districts of Cooch Behar and Jalpaiguri (except in the mountainous belts), in Siliguri sub-division of Darjeeling district, parts of West Dinajpur and Malda district and areas to the north of the river Ganga. In addition to the above, parts of Murshidabad and Hooghly, Malda, Burdwan and Howrah districts are also considered suitable for the sinking of shallow tubewells.

Present Stage of Irrigation Development

21.11 Prior to 1951, there were three important canal systems namely, the Damodar Canal, the Midnapore Canal and the Eden Canal capable of providing irrigation to an area of 0.75 million hectares. However, minor irrigation works, mostly tanks, formed the main source of irrigation, which at the end of 1950-51 benefited 0.79 million hectares.

With the commencement of the First Five Year Plan, the State Government undertook the construction of a number of major projects. Some of them are:

(i) D.V.C. & improvements and extension scheme:	364,300	hectares
(ii) Mayurakshi Project	246,870	,,
(iii) Kangsabati Project	385,000	,,

As a result the net irrigated area at the end of 1964-65 had increased by 1.48 million hectares.

21.12 Some of the important projects are described briefly in the following paragraphs:

Damodar Valley Project

The Damodar Valley project was designed as a multipurpose project to provide irrigation, flood control and power. As originally envisaged, the project was to consist of eight dams and a barrage, for providing perennial irrigation to 0.31 million hectares in West Bengal. Subsequently, it was decided to build only four dams at Maithon, Panchet Hill, Tilaiya and Konar respectively—and to provide kharif irrigation to 0.39 million hectares and rabi irrigation to 0.12 million hectares. With the increase in the demand for water for industries, the supplies for irrigation were reviewed from time to time and finally pegged at 0.34 million hectares in kharif and of 22,300 hectares in rabi. The salient features of the four dams are as follows:

Table 21.4

Damodar Valley Project

Salient features	Konar	Maithon	Panchet Hill	Tilaiya
1	2	3	4	5
Name of river	Konar	Barakar	Damodar	Barakar
Type of dam	Earth dam with concrete spillway	Earth dam with concrete spillway	Earth dam with concrete spillway	Concrete
Length (metres)	Earth dam 3,549 spillway 110	994	2,545	366
Maximum Height (metres)	49 above river bed	49 above river bed	49 above river bed	30 above river bed
Gross storage capacity (m.cu.m.)	336	1,357	1,493	395
Live storage capacity (m.cu.m.)	276	—	1,307	321
Benefits—Power	Not finalised	Designed primarily for flood control, power 60 MW	Designed primarily for flood control, power 40 MW	Power 40 MW
Cost (Rs. million)	97.5	179.7	191.4	37.1
Date of start	1950	1951	1952	1950
Date of completion	1955	1958	1959	1953

Source : CW&PC—Irrigation & Power Projects (1970)

The Durgapur barrage across the Damodar river where irrigation starts was completed in 1955. It is 692 m in length and nearly 12 m above the bed level of the river. Two canals take off from the barrage—the R.B. Canal 89 km long and the L.B. Canal 137 km.

The initial development of irrigation under the project was slow as the farmers were reluctant to take water. The field channels were absent. With the passage of time, the farmer's reluctance relaxed. The State Government has undertaken the construction of field channels. Of the ultimate area of 0.34 million hectares in kharif and 22,300 hectares in rabi, the area irrigated during 1968 was 0.28 million hectares in kharif and 17,000 hectares in rabi.

Mayurakshi Project

The Mayurakhsi Project comprises a masonry dam 640 m. long and 47 m. high across the river Mayurakhsi at Messanjore in the Santhal Parganas about 42 km from border between Bihar and West Bengal. The reservoir has a gross storage capacity of 617 m.cu.m. (live storage 555 m.cu.m.). The canal system starts from the Tilpara barrage about 32 km downstream of the dam. The project provides irrigation facilities to 0.25 million hectares in Birbhum district. A canal taking off directly from the dam provides irrigation to 11,000 hectares in Santhal Parganas.

The work on the project started in 1946 and was completed in 1956. However, some work on the field channels is yet to be completed. The estimated cost of the project is Rs. 204.6 million. During 1969, an area of 0.22 million hectares was irrigated, 0.21 million hectares in kharif and 16,000 hectares in rabi.

The Kangsabati Project

The Kangsabati Project is the third major irrigation project undertaken in the State to benefit 0.39 million hectares (0.32 million hectares in kharif and 0.07 million hectares in rabi) in districts of Bankura, Midnapore and Hooghly.

The project envisages the construction of an earthen dam 3,200 m. long across the rivers Kangsabati and Kumari, upstream of the confluence of the two rivers near Ambikapur in Bankura district. A concrete spillway will be provided for surplussing the floods. The 41 m. high dam will have a gross storage capacity of 1,135 m.cu.m. and a live storage of 987 m.cu.m.

Work on the project started in 1956 but due to the paucity of funds, the progress has been very slow. During recent years, however, the tempo has picked up somewhat, and the project is expected to be completed

during the Fourth Five Year Plan. Though the project as a whole has not yet been completed, it has been possible to use the water impounded by the dam across the Kangsabati to irrigate lands. During 1969, an area of 0.1 million hectares was irrigated in the kharif season. The estimated cost of the project was originally Rs. 252.6 million, but now it has risen to Rs. 460.0 million.

The State Government has also undertaken a number of medium schemes some of which have been completed and the remaining are in progress. Table 21.5 shows some salient features of the medium schemes.

Table 21.5*

Medium Projects in West Bengal

Name of project	Location	Date of completion	Estimated cost (Rs. million)	Ultimate benefits (hectares)
1	2	3	4	5
Completed Projects				
Berai Canal	Bankura	1952-53	2.18	2,020
Suvankar Danra	Bankura	During II Plan	1.72	2,430
Karatowa	Jalpaiguri	1969	4.64	8,820
Continuing Projects				
Soharajore	Purulia	IV Plan**	556	4,850
Hinglow	Birbhum	V Plan**	9.79	12,440
Bandhu	Purulia	IV Plan**	4.23	2,020

*Source: CW&PC — Note Volume (Irrigation Chapter) of West Bengal March, 1970
**Estimated dates of completion.

Minor Irrigation

21.13 Minor schemes form an important source of irrigation in West Bengal. In 1951-52, when the gross irrigated area was 11.16 million hectares minor irrigation sources accounted for an area of 0.78 million hectares constituting 67 per cent of the gross area irrigated. During the Plan period there has been a decline under minor irrigation, the area having dropped to 0.77 million hectares (1964-65). This is presumably because of tanks having become derelict. Irrigation under tanks declined from 0.38 million hectares in 1951-52 to 0.34 million hectares during 1964-65. Similarly there has been a reduction in the area irrigated under 'other sources' from 0.28 million hectares (1951-52) to 0.24 million hectares in 1964-65.

In West Bengal, dug wells are not usually used for agricultural purposes. They hardly irrigated 16,000 hectares. However, during the Fourth Plan, the 'dug well programme' is being operated in districts of Bankura, Purulia and parts of Burdwan and Midnapore districts. Loans are being advanced to farmers, or groups of farmers, for digging wells. The State Government expects to continue the scheme in subsequent Plans.

Table 21.6 shows the districtwise position of tubewells as on 31.3.69.

Table 21.6

Tubewells in West Bengal*

District	No. of tube-wells as on 31.3.69	Area irrigated (hectares)
1	2	3
Nadia	449	22,100
24-Parganas	164	11,250
Murshidabad	233	10,850
Bankura	59	895
Midnapore	67	2,080
Birbhum	26	485
Hooghly	122	8,300
Howrah	18	637
Burdwan	182	8,680
Malda	82	1,275
Cooch Behar	15	122
Jalpaiguri	33	324
West Dinajpur	92	740
Darjeeling	1	20
Total	1,543	67,758

*Source: State Replies to Irrigation Commission

About 11,500 shallow tubewells have been sunk by private persons. The State Government considers that 0.1 million shallow tubewells can be sunk in the State.

The State Government has also installed a number of pumps for lifting water from rivers and streams. Nearly 20,000 pumping sets of 3 to 10 H.P. have been distributed to the cultivators.

21.14 The net irrigated area from all sources stood at 1.48 million

hectares at the end of 1964-65, the latest year for which figures were available. The details are as follows:

Government Canals		0.55 million hectares
Private Canals		0.40 ,, ,,
Tanks		0.34 ,, ,,
Wells		0.02 ,, ,,
Other sources		0.17 ,, ,,
	Total:	1.48 million hectares

Ayacut Development and Soil Conservation

21.15 There is no programme of ayacut development as such in this State. However, some works pertaining to soil and water conservation have been taken up.

Soil conservation works were taken up in West Bengal during the Third Plan. The first few years were spent mainly in working out the details and strengthening the machinery. Since 1966-67 the scope of the work has been enlarged and the programme has gained momentum.

The programme includes soil and water conservation of eroded lands. The lands contour-bunded and reclaimed are producing groundnut, high-land paddy, dhaincha, niger and til. During the Third Plan 13,000 hectares were contour-bunded against 4,700 hectares and 5,400 hectares in 1966-67 and 1967-68 respectively.

A few soil conservation schemes, mostly involving the stabilisation of land-slides in Darjeeling district, were taken up by the department of Irrigation and Waterways during the Third Plan. Of these, the Master Plan for soil conservation in the Lish catchment, is important and under execution.

Drought Affected Areas

21.16 In their reply to the questionnaire the State Government has reported that the areas affected are spread over districts of Purulia, Bankura, Burdwan, Midnapore, Birbhum, Malda and West Dinajpur and measure 0.8 million hectares.

Such areas of Purulia, Bankura, Burdwan and Midnapore are undulating and hilly. Their soil is mostly composed of sandy loam and laterite gravel and has very low moisture retention capacity. The drought-affected area of Malda comprises the borind which is a comparatively high tract of sticky, hard soil of low fertility. This soil fails to yield a good crop if, rainfall is not adequate and timely.

Drought in West Bengal is more often caused by want of adequate and timely rainfall, rather than by total failure of rains. Due to wide regional variations, the districts mentioned above receive less than the State's average rainfall of 1750 mm. The distribution is erratic.

Irrigation at present in the drought-affected areas is poor. Of nearly 0.55 million hectares under cultivation, hardly few thousand hectares are provided with irrigation through minor irrigation works which are likely to fail when the monsoon is poor. These conditions are reported to have been responsible for frequent crop failures.

The Kangsabati Project will irrigate about 0.39 million hectares in Bankura, Hooghly and Midnapore districts. A second project across the river Hinglow has also been undertaken to provide irrigation to about 12,400 hectares in Birbhum district. These two projects, on completion, will go a long way in providing relief to the drought-affected belt of the State.

There are possibilities of tapping other rivers and streams in the region. The State Government is investigating the possibilities of harnessing the water resources of these rivers to provide relief in the drought-affected regions.

A systematic assessment of the ground water resources in the drought-affected regions has not yet been made. Random observations of fluctuations in ground water levels in different areas of the State, made by River Research Institute of the State indicate that the subsoil water level in the drought-affected areas varies from 4 to 7 m except in Malda district. The ground water available in the region is suitable for irrigation. It is necessary, therefore, to carry out a systematic ground water survey of the drought-affected areas of West Bengal.

Future Development of Irrigation

21.17 Though for the State as a whole, irrigation facilities have improved in successive Plan periods, the districtwise availability of irrigation is extremely uneven. While the percentage of irrigated area in the districts of Birbhum, Burdwan, Hooghly and Bankura was 73%, 57%, 49% and 38% of the cultivated area, its percentage in the districts of Nadia, West Dinajpur, Malda and Cooch Behar was as low as 2.6%, 3.5%, 6% and 5.3% respectively. Moreover, the existing irrigation systems cater only for kharif irrigation. There is almost total absence of double cropping under irrigated conditions. Hence almost 90 per cent of the total irrigated area grows paddy.

The State Government proposes to take the following steps to overcome the shortcomings in the existing system:

(a) achievement of the full potential of existing irrigation projects which will cost least and take shortest time;

(b) tapping the perennial river flows to facilitate multiple cropping; and
(c) utilisation of the ground water resources through deep and shallow tubewells.

The Mayurakshi System has almost achieved its full potential except for 20,000 hectares under kharif and 324 hectares under rabi, which are expected to be covered shortly after the completion of the field channels. The full irrigation potential under the D.V.C. System is also expected to be realised during the Fourth Plan, with the completion of the schemes for the construction, extension and improvement of water courses. The State Government also expects to complete its third major project viz. Kangsabati Project, during the Fourth Plan period. The three projects will eventually provide irrigation to an area of nearly one million hectares.

Table 21.7

New Projects Proposed by West Bengal*

Name of scheme	Benefits(Hectares)	Cost (Rs. million)
1	2	3
Upper Kangsabati	60,000	66.30
Maliarjore	1,260	2.28
Tangon	8,500	15.00
Kumari	4,000	2.50
Sali	2,000	1.60
Dolong	4,000	3.84
Jarda	2,800	2.50
Gandeswari-Dwarakeswari	8,000	15.00
Total	90,560	109.02

**Source:* Preliminary Memorandum submitted to Irrigation Commission.

21.18 The State Government has formulated two new major irrigation projects viz. (i) The Teesta Barrage Scheme and (ii) The Subarnarekha Project.

The Teesta Barrage Scheme

The scheme envisages the construction of a barrage across the Teesta to tap the perennial flow of the river to irrigate a large tract of land in north Bengal. The scheme is expected to irrigate 0.55 million hectares in kharif and 0.12 million hectares in rabi. It is also expected to provide irrigation to

0.37 million hectares during the pre-monsoon months. The project is expected to ensure double cropping over 0.45 million hectares in West Bengal and 0.1 million hectares in Bihar. The estimated cost of the project is Rs. 800 million of which West Bengal's share would be Rs. 640 million.

Subarnarekha Project

The other major irrigation scheme is the Subarnarekha Project estimated to cost Rs. 200 million which will benefit 73,000 hectares during kharif and 16,000 hectares during rabi in Midnapore district.

The State has also under contemplation a number of other projects in addition to the continuing medium schemes of Saharajore, Hinglow and Bandhu. The details of the other schemes are shown in Table 21.7.

Table 21.8
Future Irrigation Possibilities

Schemes	Benefits (million hectares)	Cost (Rs. million)
1. Completion of continuing major schemes	0.8 kharif 0.07 rabi	250.0
2. (*a*) Teesta	0.45 multiple cropping	640.0 (West Bengal share)
(b) Subarnarekha	0.08 kharif 0.02 rabi	200.0
3. Medium irrigation schemes (including continuing ones)	0.11	128.2
4. River lift schemes	0.80	315.0
5. Deep tubewell	0.20	315.0
6. Shallow tubewell	0.20	Loan scheme
7. Dug well	0.008	,,
8. Minor irrigation	0.060	60.0
Total:	1.798	1,908.2
Say	1.8 million	say Rs 1,908 million

There are proposals to tap ground water by extending the deep and shallow tubewell programme. A programme of dug wells for irrigation has also been in hand.

21.19 The future possibilities in West Bengal are summed up in Table 21.8 on pre-page.

It is thus possible to bring an additional 1.8 million hectares under irrigation with an expenditure of approximately Rs. 1,908 million. During the Fourth Plan, the State Government has set a target of adding nearly 0.6 million hectares to its irrigation potential leaving the remaining 1.2 million hectares for the Fifth and subsequent Plans.

Floods and Drainage

21.20 The flood and drainage problem of West Bengal are the following:

(*i*) North Bengal affected by floods in Himalayan rivers like Teesta, Torsa, Jaldhaka, etc.

(*ii*) Western and southern districts, affected by floods in the Bhagirathi-Hooghly and tributaries like the Damodar, Ajoy, Kangsabati, Mayurakshi etc.

(iii) The southernmost region of the State viz. the Sunderbans affected due to poor drainage of the innumerable channels and tidal creeks.

Districts of Jalpaiguri, Cooch Behar and Siliguri sub-division of Darjeeling in the northern region suffer frequently from floods in Himalayan rivers which carry enormous amounts of debris and coarse sediments. They are also subject to flash floods. The heavy sediment deposition on river beds, particularly in the flatter reaches, reduces the capacity of the river to carry the flood discharge, and the flood waters overtop the banks and inundate the adjoining areas. Sometimes the rivers erode their banks and change courses abruptly, opening new channels and causing considerble damage to neighbouring areas. According to records, very heavy floods occurred in north Bengal in the years 1877, 1885, 1892, 1895, 1900, 1902, 1905, 1906, 1926, 1948, 1950, 1952 and 1954. The most recent flood was in 1968 when nearly 1,500 sq. km. of cultivated area was very badly affected.

Prior to 1954, there was not much control of flood in north Bengal. Since then, works have been undertaken to afford flood relief to many towns such as Jalpaiguri, Siliguri, Cooch Behar, Alipurduar, etc. by constructing protective embankments. The State Government has drawn up a Master Plan for flood control in a number of rivers in north Bengal. These schemes include the construction of flood embankments, soil conservation, afforestation and drainage, etc. The names of the schemes are as follows:

(i)	Master Plan for the Teesta river—Cost	Rs. 1,140	million
(ii)	Master Plan for the Jaldhaka river—Cost	Rs. 947	,,
(iii)	Master Plan for the Raidak river—Cost	Rs. 610	,,
(iv)	Master Plan for the Torsa river—Cost	Rs. 288	,,

Due to the paucity of funds, the schemes have been phased over a period of 10 years. The State Government has suggested that the responsibility for flood control in north Bengal be taken over by the Central Government.

The problem of western and southern regions can be broadly classified into (a) inundation and (b) drainage congestion. The areas adjoining these rivers are generally below the high flood level in streams, and hence, whenever there are floods these areas are submerged. Due to the gentle slope, there is heavy drainage congestion. When the main rivers are in flood, the water in their tributaries backs up to overtop the channels and leads to submersion of large areas.

After the devastating floods of 1959 in this part of West Bengal, the State Government appointed a Flood Enquiry Committee which submitted a plan for relieving drainage congestion and flood control. The works suggested are being gradually executed, depending on the availability of funds. The main schemes are:

Name of scheme	Area benefited
(*i*) Sonarpur-Arpanch-Matla Scheme	19,000 hectares
(ii) Bagjola-Ghuri-Jatragachi Scheme	10,300 hectares in addition to reclamation of 8,600 hectares
(iii) Amta Basin Drainage Scheme	8,700 hectares
(iv) Sealdahgong Basin Drainage	36,000 hectares
(v) Nowi Basin Drainage Scheme (under sanction)	21,200 hectares

In the extreme southern part of West Bengal viz. the Sunderbans which covers an area of 8,000 sq. km., the problem of drainage is of a different nature. The area is intersected by numerous tidal creeks and inlets. About 3,600 sq.km of area have been reclaimed so far by the erection of 3,400 km of embankments, but the protection afforded by the embankments is limited. Although higher than the normal high water level; severe cyclones cause the bunds to be overtopped and breached, resulting in the inundation of protected land.

A master plan for the Sunderbans area known as the Sunderbans

Delta Project has been drawn up by the River Research Institute in collaboration with Netherland Engineering Consultants, which involves the construction of closing-dams across the main estuaries near the sea face. The scheme is estimated to cost about Rs. 700 million and will give permanent benefit to about 1,600 sq. km.

Waterlogging

21.21 The waterlogging problems in the irrigated areas of Midnapore, 24-Parganas, Howrah and Hooghly districts are acute. More than 2,500 sq. km. of Midnapore are stated to be subject to waterlogging. In other districts another 12 sq.km. are liable to waterlogging. The anti-waterlogging measures undertaken to overcome the evil comprise excavation of new drainage channels, desilting and resectioning of existing drainage channels, construction of flood embankments, strengthening and raising of existing embankments; and augmenting the capacity of drainage channels with the help of pumps.

Schemes benefiting 700 sq.km have been completed and works to protect an additional 280 sq.km are in hand.

Criteria for Sanctioning Projects

21.22 In West Bengal, on all major irrigation schemes and medium schemes costing above Rs. 2.5 million, the financial criteria as applicable to productive schemes are usually applied. Productive schemes, as defined in the Irrigation Code of West Bengal are schemes, where the net revenue, (gross revenue less working expenses and maintenance and depreciation charges) on the expiry of 10 years from the date of its completion repays the prescribed annual interest charges on the capital invested.* In respect of minor schemes executed by the Irrigation and Waterways Department costing between Rs. 0.2 to Rs. 2.5 million, a benefit-cost study is made before sanctioning them.

As the cost of irrigation schemes has gone up considerably due to the increase in the prices of capital goods, materials and labour charges and it has become difficult for many desirable projects to satisfy the financial criteria, the State Government has veered round to opinion that projects should be sanctioned on the basis of benefit-cost ratio 1:5.

Water Rates

21.23 The water rates in West Bengal are not uniform. They vary

*Capital invested includes: i) direct charges; ii) indirect charges; and iii) arrears of simple interest, if any.

from project to project. The following water rates prevail in different projects of the State.

Table 21.9
Water Rates in West Bengal

Project	Water rate Rs./acre	Remarks
1	2	3
Midnapore Canal	2.50	
Mayurakshi	10.00 (inclusive of both kharif and rabi	Maximum as provided under Bengal Development Act 1935.
D.V.C.	12.50 (kharif) 12.50 (rabi)	Maximum rate for kharif as provided under West Bengal Irrigation Act 1958 (Imposition of water rates for D.V.C. water).
Kangsabati	Not yet levied	
Medium and minor irrigation schemes	6.50	
Deep tubewells and river lift pumps	11.00 First crop 15.00 Second crop 15.00 Third crop	Water rates imposed by Agriculture Department under executive instructions.

The State Government has under its consideration a comprehensive bill which will apply to all projects—major, medium and minor—and lay down the maximum and minimum limits of water rates. Meanwhile, there is a proposal to amend the Bengal Development Act 1935 and to abolish the maximum limit of Rs. 10/- per acre per year prescribed in the Act, so that separate levies could be made for the kharif and rabi seasons.

Betterment Levy

21.24 There is no provision in the State for the levy and collection of betterment charges.

We would like that our recommendations in respect of water rates and betterment levy made in Chapter XI of the First Volume should be borne in mind in future enactments.

सत्यमेव जयते

APPENDIX 1.1

Salient Features of Projects Irrigating 4,045 Hectares and Above—Andhra Pradesh

Sl. No.	Name of Project	Source of water	Storage/ Non-storage	Capital cost (Rs. million)	Year of completion	Type	Max. height (metres)	Length (metres)	Storage capacity (m.cu.m.)		Full Supply Discharge (Cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
									Gross	Live				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Nizam Sagar	Manjira	Storage	39.18	1931	Masonry	48	3,901	841	725	97.1	217,126	111,287	
2.	Pocharam	Aleru	,,	3.21	1938-39	,,	30	640	NA	53	6.4	9,712	6,070	
3.	Pakhal	NA	,,	0.39	—	—	—	NA	NA	—	—	—	5,059	
4.	Palair	Palair	,,	2.18	1940-41	Earthen	20	618	NA	66	9.1	7,973	7,589	
5.	Wyra	Wyra	,,	3.08	1929	Composite	19	2,369	NA	59	5.9	7,042	7,037	
6.	Godavari Delta System	Godavari	Weir	29.55	1890	—	—	2,136	—	—	212.4	473,461	558,458	
7.	Yeluru Canal System	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15,378	
8.	Nagavali	Nagavali	Weir	1.95	1913	—	—	—	—	—	—	12,626	10,910	
9.	Srikakulam Minor River System			0.29			NA						27,443	
10.	Krishna Delta	Krishna	Weir/ Barrage	74.09 } 29.16 }	1898 } 1958 }	—	—	1,051	—	—	Lt.313.55 } Rt.183.5 }	66,583	556,435	Since built as a barrage
11.	Dindi	Dindi	Storage	3.89	1943	NA	25	1,859	NA	68	8.50	15,783	7,891	
12.	K. C. Canal	Tunga-bhadra	Weir/ Remodelling	76.47 } 75.77 }	1870 } 1962 }	—	—	1,328	—	—	85.0		122,213	Area irrigated after remodelling
13.	Penner Canal System	Penner	Weir	70.70	1894	—	—	NA	—	—	NA	76,000	74,343	
14.	Romperu Drainage	NA	NA	12.80	NA	NA	NA	NA	NA	NA	NA	NA	4,168	
15.	Koil Sagar	Peddavugu	Storage	9.12	1955-56	NA	26	1,328	NA	45	5.1	23,351	5,868	
16.	Rallapad	Muneru	,,	10.58	1957	Earthen	15	2,952	NA	420	4.6	4,455	4,451	

Appendix 1.1—*contd.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
17.	Tungabhadra	Tunga-bhadra	Storage		1956	Masonry	49	2,440	3,690	3,341				
	i) Low level Canal			128.13	1957	—	—	—	—	—	70.8	198,709	60,245	
	ii) High Level Canal Stage I			188.66	1970-71	—	—	—	—	—	65.1 } 113.3 }	260,021	55,615	
	iii) High Level Canal Stage II			112.60	V Plan	—	—	—	—	—				
18.	Bhairavanitippa	Hagari/ Vedavali	Storage	14.58	1961-62	Earthen	16	2,239	NA	65	5.1	4,856	6,880	
19.	Narayanapuram Anicut	Nagavali	Weir	9.69	1963-64	Masonry	—	NA	—	—	12.8	19,873	14,904	
20.	Kaddam	Kaddam	Storage	79.85	1965-66	Composite	41	2,102	221	137	31.1	53,013	34,398	
21.	Nagarjunasagar Stage I	Krishna	,,	1648.90	V Plan	Masonry Earthen	125	1,450 } 3,414 }	11,553	6,796	Rt.311.5† Lt.311.5†	807,984 35,612	831,213	†Capacity of unlined Rt. Bank canal is 311.5 cumecs. Masonry works are constructed for 594.7 cumecs Lt. Bank Canal capacity is also 311.5 cumecs. Masonry works are constructed for 424.8 cumecs (Report of the Krishna Godavari Commission, Annexure X.)
22.	Musi	Musi	,,	40.90	IV Plan	Composite	21	4,129	NA	136	9.3	23,351	16,916	
23.	Rajolibanda Diversion	Tunga-bhadra	Weir	38.30	1969-70	Masonry	9	820	NA	48	21.8	47,620	36,612	
24.	Torigeddu Pumping Scheme	Godavari	,,	7.71	IV Plan	Pumping	—	—	—	—	5.0	6,880	5,516	
25.	Tandava	Tandava	Storage	9.84	IV Plan	Earthen	32	201	NA	168	NA	NA	18,575	
26.	Pochampad	Godavari	,,	401.00	IV Plan	Composite	42	765 }	3,186	2,305	NA	NA	230,668	
27.	Penner Canal	Penner	,,	21.32	IV Plan	Masonry	—	12,588 }	—	—	NA	NA	6,880	
28.	Pampa Reservoir	Pampa	,,	6.00	1969-70	Composite	11	NA	NA	NA	NA	NA	5,261	
29.	Vottigedda	Vottigedda	,,	13.57	NA	,,	NA	2,908	NA	23	Rt.6.5 Lt.1.8	NA	6,747	
30.	Gajuladinne	Hindri	,,	9.64	NA	NA	NA	NA	NA	NA	NA	NA	5,059	
31.	Guntur Channel	Krishna	Non-storage	17.00	IV Plan	Canal	—	—	—	—	17.0	—	10,926	
32.	Gandipalem	Pillaperu	Storage	9.70	,,	NA	NA	NA	NA	NA	NA	NA	4,047	

Source: (1) Irrigation Statistics of India 1960-61—CW&PC
(2) Note—Volume of Irrigation Chapter of Andhra Pradesh—CW&PC (July, 1969)
(3) India—Irrigation and Power Projects—CW&PC (1970)

APPENDIX 3.1

Salient Features of Projects Irrigating 4,000 Hectares and Above

Name of Project	Source of water/ name of river	Storage/ non-storage	Capital cost (Rs. million)	Year of completion	Type	Max. height (metres)	Length (metres)	Storage capacity (m.cu.m.) Gross	Live	Full supply discharge (cumec)	C.C.A. (hectares)	Gross area to be irrigated (hectares)
1	2	3	4	5	6	7	8	9	10	11	12	13
Son Canals	Son	Non-storage	26.82	1875						5.09		347,230
Tribeni Canal	Gandak	-do-	8.16	1914						2.32		48,180
Dhaka Canal	Lalbakeya	-do-	0.63	1901								6,480
Sakri Lower Valley	Sakrinadi	-do-	3.38	1952								20,240
Tribeni Canal Expansion	Gandak	-do-	2.98	1956								11,330
Botane Irrigation	Botane	-do-	1.85	1950								6,680
Upper Morhar Irrigation Scheme	Morhar	-do-	5.61	1961								14,570
Lilajan Irrigation Scheme	Lilajan	-do-	6.50	1958								22,660
Durgawati	Durgawati	-do-	3.66	1957								10,520
Kaurihari	Natra Baghel & Kaurihari	-do-	5.65	1960								11,660
Dhawan Irrigation Scheme		-do-	1.55	1961								4,250
Lower Morhar		-do-	5.68	1962								19,970
Mayurakshi L.B.C.	Mayurakshi	Storage	8.11	1957								10,120
Adri		Non-Storage	1.53	1959								4,250

Appendix 3.1—*contd.*

1	2	3	4	5	6	7	8	9	10	11	12	13
Tribeni Canal Extension	Gandak	-do-	11.20	1962								25,130
Kamla Canal	Kamla	-do-	3.09	1958								15,380
Lower Kiul	Kiul	-do-	8.77	1959						0.31	21,853	25,900
Khajia Phase II including Chandan Phase I			2.21	1959							25,293	19,000
Panchane Phase II	Lachani	Non-storage	4.41	1963								12,550
Sakri Canal Phase II		-do-	3.79	1961								5,060
Kohira	Kohira	Storage	5.68	1961	Masonry dam	12.80	134		25			10,320
Badua Reservoir Project	Badua	-do-	62.80	1969	Earth dam	40.23	472	128.3		109.78		42,490
Sunder River Scheme	Sunder	Non-storage	1.47	1958							7,851	5,261
Irrigation of chaurs			3.86	1956								39,940
Small dams in hilly districts			3.11	1956								15,010
Roro Irrigation	Roro	Non-storage	13.61	1970						0.23	11,331	10,927
Emergency River Pumping Scheme			3.90	1956								5,260

Source: 1. Irrigation Statistics of India (1960-61)—CW&PC—March, 1968
2. India—Irrigation and Power Projects—CW&PC—April, 1970
3. Note Volume of Irrigation Chapter of Bihar (Unpublished)—CW&PC, March, 1970.

APPENDIX 4.1

Classification of Area in Gujarat—1967-68

(Thousand hectares)

District	Reporting area	Area under forests	Not available for cultivation	Other uncultivated land excluding fallow lands	Fallow lands	Net sown area	Total cropped area
1	2	3	4	5	6	7	8
Ahmadabad	852	2	163	40	33	614	635
Banaskantha	1,204	154	43	107	69	831	931
Baroda	780	64	79	87	7	543	559
Broach	773	158	100	38	18	459	462
Dangs	179	96	21	3	10	48	48
Kaira	692	27	98	34	10	523	582
Mehsana	906	7	64	127	11	698	769
Panchmahals	894	233	76	74	38	473	545
Sabarkantha	708	132	37	52	37	450	498
Surat	738	168	63	45	15	447	472
Bulsar	525	128	57	54	11	295	322
Amreli	642	29	25	60	26	502	514
Bhavnagar	926	27	107	129	39	624	638
Jamnagar	1,041	76	224	106	39	597	633
Junagadh	1,062	181	113	147	36	585	642
Kutch	4,420	95	3,216	254	207	649	665
Rajkot	1,106	55	196	117	21	738	768
Surendranagar	1,017	13	193	79	7	674	681
Gandhinagar	68	—	6	8	1	52	57
Total:	18,533	1,627	4,878	1,541	685	9,802	10,420

APPENDIX 4.2

Area under Different Crops and Area Irrigated in Gujarat—1967-68

(Thousand hectares)

Crop	Total cropped area	% to total cropped area	Total irrigated area
1	2	3	4
Rice	507	4.86	138
Jowar	1,343	12.89	36
Bajra	1,867	17.92	47
Maize	268	2.57	11
Wheat	554	5.32	353
Other cereals and millets	282	2.71	14
Total cereals & millets	4,821	46.27	599
Pulses	529	5.08	6
Total food grains	5,350	51.35	605
Sugarcane	28	0.27	28
Condiments & spices	89	0.85	23
Fruits, vegetables & other food crops	85	0.81	129
Total food crops	5,552	53.28	785
Groundnut	1,942	18.64	19
Total oilseeds	2,194	21.06	53
Cotton	1,640	15.74	208
Total fibres	1,648	15.82	208
Tobacco	94	0.90	23
Total narcotics	114	1.09	—
Fodder crops etc.	912	8.75	97
Total non-food crops	4,868	46.72	381
Gross area sown	10,420	100.00	1,166

APPENDIX 4.3

Major and Medium Irrigation Schemes Cost and Ultimate Benefits

S. No.	Name of project	Estimated cost (Rs. million)	Ultimate benefit (000 hect.)
MAJOR PROJECTS			
1.	Kakrapar	180.50	227.5
2.	Mahi Stage I	245.70	186.2
3.	Shetrunji (Palitana)	69.60	34.8
4.	Banas (Dantiwada)	108.80	44.5
5.	Hathmati Reservoir	54.40	37.6
6.	Mahi Stage II (Kadana)	210.00	16.6
7.	Narmada (Broach)	1,097.00	403.7
8.	Ukai	1,044.00	152.4
MEDIUM PROJECTS			
1.	Bhimdad	2.26	1.15
2.	Brahmani	9.09	3.85
3.	Daswada Tank	0.64	0.92
4.	Gajod	1.26	1.15
5.	Ghee	2.03	0.83
6.	Gomdli	2.15	0.93
7.	Hiran	1.81	2.10
8.	Kankawati	1.72	1.56
9.	Karad Tank	9.99	4.53
10.	Kaila	2.69	0.87
11.	Machhu-I	15.90	6.76
12.	Malan	4.19	2.33
13.	Moj	9.65	4.81
14.	Moti Fatehwadi	7.23	12.92
15.	Munjisar	5.38	1.34
16.	Puna	2.21	1.01
17.	Patadungri	7.72	3.08
18.	Rangola	6.64	3.50
19.	Rawal	1.73	0.45
20.	Sunandro	1.16	0.67
21.	Sasoi	7.70	3.06
22.	Surajwadi	3.43	1.04
23.	Vir	0.90	1.38
24.	Aji	6.88	1.71
25.	Bhogavo-I	6.81	1.54
26.	Harnev	5.11	2.67
27.	Hiran	8.99	2.63
28.	Karol	1.21	1.21
29.	Machundri	2.30	0.45
30.	Ozat	6.92	2.39
31.	Demi	5.30	1.58
32.	Fulzar	4.45	1.21
33.	Limdi	5.81	3.20
34.	Rojki	2.70	1.54
35.	Sakroli	2.42	1.22
36.	Suvi	2.96	1.34
37.	Wadhwan	6.67	0.61
38.	Bhadar	43.30	17.16
39.	Ghelo	4.42	3.14
40.	Meshwa	31.43	23.90
41.	Niruna	5.01	5.67
42.	Sapada	1.91	1.01
43.	Shetrunji (Khodiar)	16.32	7.69
44.	Wartu	4.98	3.17
45.	Rudramata	10.60	7.20
46.	Dhatrawadi	10.50	2.43
47.	Gajansar	2.00	1.62
48.	Goma	8.70	2.19
49.	Kalindri	4.30	0.91
50.	Machhu-II	21.39	7.69
51.	Saraswati	21.20	8.74

APPENDIX 4.4

Drought Areas in Gujarat

District	Taluk
(i) Banaskantha	1. Santhalpur
	2. Radhanpur
	3. Wao
	4. Tharad
	5. Dhanera
(ii) Mehsana	1. Harij Mahal
	2. Sami
	3. Chanasma
	4. Patan
	5. Kadi
	6. Kalol
(iii) Ahmadabad	1. Viramgam
	2. Dhanduka
	3. Dholka
	4. Sanand
(iv) Kaira	1. Cambay
	2. Matar
	3. Mohmedabad
(v) Broach	1. Jambusar
	2. Waghra
	3. Hansot
(vi) Kutch	1. Anjar
	2. Nakhtrana
	3. Abdasa
	4. Lakhpat
	5. Rahpur
	6. Khavda
	7. Khadir
	8. Mundra
	9. Bachau
	10. Mandvi
	11. Bhuj
(vii) Surendranagar	1. Dusada
	2. Wadhwan
	3. Muli
	4. Dhrangodhra
	5. Halvad
	6. Limbdi
	7. Sayla
	8. Lakhhar
(viii) Jamnagar	1. Okhamandal
	2. Kalyanpur
	3. Jodia
	4. Kalavad
(ix) Rajkot	1. Malia
	2. Morvi
	3. Wankaner
(x) Bhavnagar	1. Bhavnagar
	2. Gadhada
	3. Vallabhipur
	4. Botad
	5. Gariadhar
	6. Kandla
(xi) Amreli	1. Amreli
	2. Khamba
	3. Jafrabad
	4. Rajula
	5. Babra
	6. Lilia
	7. Lathi

APPENDIX 4.5

Structure of Water Rates in Force in Gujarat with Effect from 15.6.1968

Name of the season or crop and other details			Rate (Rs. per acre)
Kharif Season			
(1) Short term paddy (requiring watering up to 14th October)			18.00
(2) Long term paddy (requiring watering up to 15th November)			25.00
(3) Paddy in reclaimed Kharlands			
1st year 2nd year			5.00
3rd year 4th year			10.00
From 5th year onwards			18.00 to 25.00
(4) Bajri, jowar & maize etc.			7.00
(5) Late kharif jowar			
Kharif			7.00
Rabi			3.00
(with every additional watering)			
(6) Other food crops, vegetables & grass			11.00
(7) Groundnut & kharif crops			15.00
Rabi Season			
1. Short-term wheat (requiring watering upto 14th Feb.)			18.00
2. Long-term wheat (requiring water upto 14th March)			25.00
3. Bengal gram			10.00
4. Jeeru (cumin seeds)			25.00
5. Fennel seeds			30.00
6. Vegetable & grass			18.00
7. Other crops			30.00
Hot Weather Crops			
8. Grass, food crops, bajri & jowar (15th January to 14th May)			18.00
9. Groundnut and others (15th January to 14th May)			30/-
Two Seasonal Crops			
10. Cotton	Kharif Rabi	10/- 18/-	28/-
11. Bidi tobacco	Kharif Rabi	8/- 12/-	20/-
12. Other varieties of tobacco	Kharif Rabi	10/- 25/-	35/-

Appendix 4.5—*contd.*

Name of the season or crop and other details	Rate (Rs. per acre)
Perennial Crops	
13. *Sugarcane*	
Pickup weir schemes	140/-
Storage schemes	150/-
14. *Plantains*	
Pickup weir	160/-
Storage	170/-
15. *Other Perennial Crops*	
Pick up weir	100/-

APPENDIX 5.1

SCHEDULE OF OCCUPIERS' RATES

Statement Showing Occupiers' Rates in Force on the Canals in the Punjab (India)

Authority	Class	Nature of Crops	Rate per acre Flow Rs.	A.	P.	Lift Rs.	A.	P.	per
1	2	3	4			5			6
Western Yamuna Canal (including Sirsa and Sunder Branches), Sirhind Canal and Bhakra Canals (including Ghaggar, Sarusati and Bist Doab Canals Sidhwan Branch)									
	I	Sugarcane (except on kharif channels)	16	8	0	8	4	0	Crop
	II	Sugarcane on kharif channels	13	8	0	6	12	0	-do-
Irrigation Branch	III	Waternuts	11	4	0	5	10	0	Crop
	III-A	Rice	9	12	0	4	14	0	-do-
	IV	Indigo and other dyes, tobacco, poppy spices and drugs	8	4	0	4	2	0	-do-
Notification No. 36842/Rev./1397/42 dated 10.11.1949	IV-A	Cotton	6	12	0	3	6	0	-do-

Appendix 5.1—*contd.*

Authority	Class	Nature of crops.	Rate per acre Flow Rs.	A.P.		Lift Rs.	A.P.		per
1	2	3	4			5			6
No. 4432/Rev./1397/48 dated 13.11.1953	V	Gardens and orchards and vegetables except turnips	8	4	0	4	2	0	Gardens and Orchards per half year, the rest per crop.
No. 36828/Rev./1397/48 dated 10.11.1949	VI	Deleted.							
	VI-A	Barley and oats (except on kharif channels)	6	6	0	3	3	0	Crop
No. 4417-Rev./1397/48 dated 13.11.1953	VI-B	Wheat (except on kharif channels).	5	13	6	2	14	9	-do-
No. 591/Rev./364/1951 dated 28.7.1951	VII	Melons, fibres (other than cotton) and all crops not otherwise specified.	7	8	0	3	12	0	-do-
No. 4422/Rev./1397/48 dated 13.11.1953	VII-A	Maize	6	6	0	3	3	0	-do-
No. 24417/Rev./1397/48 dated 13.11.1953	VIII	Oilseeds (except rabi oilseeds on kharif channels)	6	6	0	3	3	0	-do-
No. 2151/Rev. dated 12.11.1951	IX	All rabi crops (except wheat and gram on kharif channels) including gardens, orchards, vegetables & fodder.	3	0	0	1	8	0	Garden orchards per half year, the rest per crop.

Appendix 5.1—*contd.*

1	2	3	4	5	6
No. 1848/Rev./1275/52 dated 14.5.1966	IX-A	Wheat and gram on kharif channels.	2 12 0	1 6 0	Crop
No. 24417/Rev./1397/48 dated 13.11.1953	X	Bajra, masur and pulses	4 14 0	2 7 0	-do-
	X-A	Gram	4 7 6	2 3 9	-do-
	XI	Jowar, cheena, grass which has received two or more waterings and all fodder crop including turnips.	3 12 0	1 14 0	Grass per half year, the rest per crop.
	XII (a)	Watering for ploughing not followed by a crop in the same or succeeding harvest.	1 8 0	0 12 0	Acre
	(b)	Village and District Board Plantations			
		(i) Any number of waterings in kharif	1 8 0	0 12 0	Half year
		(ii) One watering in rabi	1 8 0	0 12 0	-do-
		(iii) Two or more waterings in rabi	3 0 0	1 8 0	-do-
	(c)	Grass—single watering in kharif or rabi	1 8 0	0 12 0	-do-

Note: Grass given two or more waterings, falls under Class XI.

Hemp, Indigo, Guara, Jantar and Arhar ploughed in as green manure before 15th September are not assessed to water rates.

APPENDIX 8.1

Salient Features of Projects Irrigating 4,000 Hectares and Above**

Sl. No.	Name of Project	Source of water	Storage/ non-storage	Capital cost Rs. million	Year of completion	Type	Max. ht. (metres)	Length (metres)	Storage capacity (m.cu.m.) Gross	Storage capacity (m.cu.m.) Live	Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. *COMPLETED PROJECTS (BY MARCH 1969)*														
I. *Preplan Projects*							NIL							
II. *First Plan Projects*														
1.	Chalakudy Stage I Stage II	R. Chalakudy	Diversion	15.33 6.00	1955-56 1965-66	Weir Extension of canals	—	195	—	—	L 8.0 R 8.0	11,500 8,195	22,990 16,390	
2.	Mangalam	R. Mangalam	Storage	10.60	1967-68	Composite	19	1060	n.a.	28	4.5	3,238	6,480	
3.	Malampuzha	R. Malampuzha	Storage	58.00	1965-66	Composite	38	1849	236	227	21.2	19,326	38,530	
4.	Peechi	R. Manali	Storage	23.50	,,	Masonry	40	225	n.a.	108	R 7.1 L 3.5	18,616	28,080	
5.	Walayar	R. Walayar	Storage	13.17	,,	Composite	31	1479	n.a.	24	3.9	3,238	6,480	
6.	Wadakkancherry	R. Wadakkancherry	Storage	10.76	,,	Earthen	26	793	n.a.	18	3.3	3,247	7,130	

Appendix 8.1—*contd.*

Sl. No.	Name of Project	Source of water	Storage/non-storage	Capital cost Rs. million	Year of completion	Type	Max. ht. (metres)	Length (metres)	Storage capacity (m.cu.m.) Gross	Storage capacity (m.cu.m.) Live	Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7.	Neyyar Stage I Stage II	R. Neyyar	Storage	22.60 17.00	1969 ,,	Masonry	39	300	n.a.	97	7.0	11,734	15,380 8,090	
III.	*Second Plan Projects*													
8.	Meenkara including Chulliar	R. Meenkara	Storage	22.00	1969	Earthen	19	963	n.a.	11	10.0	n.a.	10,930	
9.	Pothundy	R. Ayalurpuzha	Storage	23.43	1969	Earthen	33	1567	n.a.	37	L 3.6 R 3.1	5,463	8,900	
IV.	*Third Plan Projects*													
							NIL							
	B. *PROJECTS UNDER CONSTRUCTION*													
I.	*First Plan Projects*													
							NIL							
II.	*Second Plan Projects*													
1.	Periyar Valley Scheme (Bhoothathankettu)	R. Periyar	Diversion	64.94	IV Plan	Masonry	—	211	—	—	n.a.	n.a.	40,996	

Appendix 8.1—*contd.*

Sl. No.	Name of Project	Source of water	Storage/ non-storage	Capital cost Rs. million	Year of completion	Type	Max. ht. (metres)	Length (metres)	Storage capacity (m.cu.m.) Gross	Storage capacity (m.cu.m.) Live	Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
III. *Third Plan Projects*														
2.	Pamba	R. Kakkad	Diversion	92.05	IV Plan	Masonry	—	79	—	—	n.a.	n.a.	33,995	
3.	Kuttiyadi	R. Kuttiyadi	Storage	52.42	,,	Masonry with earthen flanks	35	171	121	113	n.a.	n.a.	31,162	
4.	Chitturpuzha	n.a.	Remodelling	10.93	,,	Remodelling	—	—	—	—	—	—	22,501**	includes existing irrigation
5.	Kanhirapuzha	n.a.	Storage	39.18	,,	Masonry	28	178	n.a.	n.a.	11.3	n.a.	19,425	
6.	Pashassi	Vallapattnam	Diversion	47.60	,,	Barrage	—	230	—	—	n.a.	n.a.	28,328	
IV. *Annual Plan Projects* (1966-69)														
7.	Kallada	R. Kallada	Storage	144.91	V Plan	Masonry	73	335	525	510	n.a.	n.a.	105,220	

***Source:* (1) Irrigation statistics of India (1960-61)—CW&PC, Ministry of Irrigation & Power, New Delhi.
(2) Note volume of Irrigation Chapter, Kerala (3/1970)—CW&PC, Ministry of Irrigation and Power, New Delhi.
(3) *India:* Irrigation and Power Projects (4/1970)—CW&PC, Ministry of Irrigation & Power, New Delhi.

Note: n.a.—Not available.

APPENDIX 9.1

Salient Features of Projects Irrigating 4,000 Hectares and Above

Sl. No.	Name of Project	Source of water/ Name of river	Storage/ non-storage	Capital cost (Rs. million)	Year of completion	Type	Max. height (meters)	Length (meters)	Storage capacity m.cu.m. Gross	Storage capacity m.cu.m. Live	Full supply discharge (cumecs)	C.C.A. (thousand hectares)	Gross area to be irrigated (thousand hectares)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. *COMPLETED PROJECTS (BY MARCH 1969)*														
I. *Preplan Projects*														
1.	Tandula Reservoir	Tandula and Sukhonala	Dam	10.63	1921	Earthen	25.02	4,423		275	62.27	246.45	66.77	
2.	Mahanadi Canal & Murramsilli Reservoir	Mahanadi & Silanrianala	Dam and anicut	15.66	1923	Earthen	25.53	2,998		164	84.89	324.80	84.98	
3.	Wainganga Canal and Sarathi Reservoir	Sarathi nala	Dam	5.13	1923	-do-	17.68	504	NA	16	22.23	50.00	31.66	

Appendix 9.1—*contd.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4.	Bhind Canals (Pagra dam and Kotwal and Pillowa Weirs)	Sank	Dam	11.63	1927	Com-posite	24.09	1,354		124	14.16	55.89	26.57	
5.	Kharung Tank	Kharung	Tank	6.56	1931	Earthen	21.11	1,924		192	43.61	50.18	37.94	
6.	Maniari Tank	Maniari	Tank	6.23	1933	Earthen	28.97	2,102		148	32.68	65.52	30.35	
7.	Parvati Project (Harsi & Kaketo Dam)	Parvati	Dam	1.75	1934	Kaketo Masonry	12.20	854		79	Under Harsi	55.90	29.64	
		,,	,,	8.37	1937	Harsi Earthen	31.79	2,135		191	16.96			
8.	Adda Dam	NA	,,	2.43	1934	Masonry and Earthen	7.32	4,831		21	4.53	6.89	4.31	
II.	*First Plan Projects*													
9.	Ari Tank	Hirri	Tank	2.78	1952	Earthen	19.51	1,338		13	4.33	8.88	4.25	
10.	Saroda Tank		Tank	16.67	1966	,,	NA	NA		NA	NA	NA	7.35	
III.	*Second Plan Projects*													
11.	Nehlesara			21.42	1968	,,	NA	NA		NA	NA	NA	4.51	
12.	Kedarnala			8.47	1969	,,	NA	NA		NA	NA	NA	4.65	
13.	Development of Maniari			3.71	1969	,,	NA	NA		NA	NA	NA	9.71	
14.	Beniganj			6.42	1969	,,	NA	NA		NA	NA	NA	4.05	
15.	Chillar			14.18	1969	,,	NA	NA		NA	NA	NA	5.26	

Appendix 9.1—*contd.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IV. *Third Plan Projects*														
							NIL							
B. *PROJECTS UNDER CONSTRUCTION*														
I. *First Plan Projects*														
1.	Chambal St. I & II	Chambal	Storage	406.70 94.00	IV Plan ,,	Masonry ,,	63.70 53.95	514 1,143	7,746 2,899	6,920 1,850	188.48	462.9 }	222.57 60.70	St. I-Gandhi-sagar, St. II-Rana-Pratap Sagar
2.	Dudhwa	Mahanadi	,,	38.89	1971	NA	24.54	2,907		NA	—	Benefits under Mahanadi Canals remodelling		
3.	Borad (Satak and Segwal)	Borad and Sonsar	Tank/pick up weir	11.35	1968-1971	NA	7.32	1,740		8	NA	NA	5.87	
4.	Gurmanala	Gurmanala	Dam	9.29	IV Plan	Masonry	—	—	NA	—	—	—	7.69	
II. *Second Plan Projects*														
5.	Tawa	Tawa	Storage	275.00	V Plan	Com-posite	50.90	1,822	2,312	2,087	NA	NA	303.51	

Appendix 9.1—*contd.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6.	Barna	Barna	Storage	47.67	1973	Earthen	46.63	396	490	407	NA	87.41	66.41	
7.	Bila	Bila	,,	26.77	IV Plan	Com-posite	30.18	NA	—	30	NA	NA	12.95	
8.	Chandrakeshar	Chandrakeshar	,,	16.31	IV Plan	Earthen	19.20	2,438	—	30	NA	NA	4.86	
9.	Removing shortage in Harsi		Feeder canal and augmenting storage	46.73	V Plan	—	—	—	—	—	—	—	23.88	
10.	Remodelling Mahanadi Canals	Mahanadi	Remodelling	28.27	IV Plan	—	—	—	—	—	—	—	56.66	
III.	*Third Plan Projects*						NIL							
IV.	*Annual Plan Projects (1966-69)*													
11.	Hasdeo Right Bank Canal	Hasdeo	Barrage/canal	49.80	1972	—	—	—	—	—	—	—	47.46	
12.	Bagh R.B.C.	Bagh	Canal	37.60	1973	—	—	—	—	—	—	—	21.37	

Source: (1) Irrigation Statistics of India, CW&PC (1960-61)
(2) Note Volume of Irrigation Chapter, Madhya Pradesh, CW&PC (August 1969).
(3) India—Irrigation and Power Projects, CW&PC (Dec., 1967).

APPENDIX 10.1

Drought Affected Areas of Maharashtra

(As identified by the Commission)

District	Name of Taluk
1	2
Poona	(i) Dhond
	(ii) Sirur
	(iii) Indrapur
	(iv) Purandhar
	(v) Haweli
Ahmednagar	(i) Shrigonda
	(ii) Karjat
	(iii) Sangamner
	(iv) Pathardi
	(v) Parner
	(vi) Ahmednagar
	(vii) Jamkhed
Sangli	(i) Jath
	(ii) Khanepur
Sholapur	(i) Pandharpur
	(ii) Nadha
	(iii) Mangalwedha
	(iv) North Sholapur
	(v) South Sholapur
	(vi) Sangola
	(vii) Karmala
	(viii) Mohol
	(ix) Akkalkot
	(x) Barshi
Satara	(i) Kandala
	(ii) Man
	(iii) Khatava
Aurangabad	(i) Vaijapur
	(ii) Gangapur
Bhir	(i) Ashti
	(ii) Patoda
	(iii) Bhir
	(iv) Georai
Osmanabad	(i) Parenda
	(ii) Bhoom
	(iii) Kalam
	(iv) Osmanabad
Nasik	(i) Baglan
	(ii) Malegaon
	(iii) Kalwan
	(iv) Chandor
	(v) Nandgaon
	(vi) Niphad
	(vii) Yeola
	(viii) Sinnar

APPENDIX 10.2

Irrigation Works under Construction in or Proposed for Drought Areas

A. *Schemes under construction*

Project	District(s) benefited	When taken up	Irrigation benefits (Thousand hectares)
1	2	3	4
Mula	Ahmednagar	II Plan	65.56
Adula	Ahmednagar	Annual Plans	5.75
Kukadi Stage I	Ahmednagar & Poona	,,	42.70
Khadakwasla Stage I	Poona	II Plan	22.30
Bhima Irrigation	Poona & Sholapur	Annual Plans	172.89
Padwal-Karwadi	Sholapur	,,	0.83
Upper Godavari	Nasik	,,	44.27
Chankapur Dam	Nasik	,,	12.04
Jayakwadi Stage I	Aurangabad & Bhir	,,	141.65
Warna	Sangli	,,	99.06
Kadi	Bhir	,,	1.10
Krishna Irrigation	Satara & Sangli	,,	106.29

B. *Irrigation Works Proposed*

Project	Drought district benefited	Irrigation benefit (Thousand hectares)
1	2	3
Khadakwasla Stage II	Poona	40.21
Pangaon Hingni	Sholapur	10.10
Nazare	Poona	3.37
Ulup	Osmanabad	0.88
Mhaladevi	Ahmednagar	16.84
Tawarja	Osmanabad	3.38
Ghatshil	Ahmednagar	2.38
Koyna Irrigation Scheme Stage I	Satara & Sangli	42.17
Koyna Irrigation Scheme Stage II	Satara/Sangli	58.52
Bhima Lift Irrigation Stage I	Sholapur	40.47
Umrodi	Satara	9.79

Appendix 10.2—*Contd.*

Project	Drought district benefited	Irrigation benefit (Thousand) hectares)
1	2	3
Wang	Satara & Sangli	28.13
Yeralwandi	Sangli & Satara	5.06
Chaskaman	Poona	46.54
Bhima Lift Irrigation Stage II	Poona/Sholapur	101.98
Kukadi Stage II	Poona/Sholapur Ahmednagar	74.70
Nira Valley Project	Poona, Satara & Sholapur	101.05
Nimgaon-Ganguard Tank	Ahmednagar	7.69
Sina Project	Sholapur & Osmanabad	18.21
Bharvir	Nasik	11.00
Pravara River Project	Ahmednagar	58.00
Dhanegaon	Osmanabad & Bhir	20.60
Lower Tirna Project	Osmanabad	29.90
Kundlika Project	Bhir	4.96
Tarali	Satara	10.56
Begampur Lift Scheme	Sholapur	129.50
Burhanpur	Poona	5.79
Hatiz Hingni	Sholapur	5.34

APPENDIX 10.3

Water Rates Prevailing in Western Maharashtra

Crops	Water rates on major irrigation projects	Water rates on medium and minor irrigation projects
1	2	3
	Rs.	Rs.
Sugarcane and plantains	180.00 per acre per year	120.00 per acre per year
Pan gardens	190.80 -do-	— —
Other perennials	120.00 -do-	70.00 -do-
Two seasonal crops	15.00 per acre	15.00 per acre
Kharif seasonal crops	6.00 -do-	6.00 -do-
Rabi seasonal crops	9.00 -do-	9.00 -do-
Hot weather seasonal crops	18.00 -do-	18.00 -do-
Pre-seasonal watering	9.00 -do-	9.00 -do-
Post seasonal watering	4.00 -do-	3.00 for kharif crops in rabi season. 4.00 for rabi crops in hot weather season.
Cotton and groundnut	Double the seasonal rates (ad hoc rate of Rs. 37/- per acre inclusive of irrigation cess is charged from 1964 as a concession upto 15.2.69. Half of this ad hoc rate is charged on new irrigation project).	Same as in Col. No. 2.

APPENDIX 10.4

Water Rates Prevailing in the Vidarbha From 1.7.1967

Crop			Water Rate Rs.
1			2
Rice	1st year		Nil
	2nd year		3.00 *
	3rd year		6.00
	4th year		9.00
Wheat*	1st year		Nil
	2nd year		2.06
	3rd year		5.53
	4th year		8.00
Kharif seasonal crops other than rice	1st year		Nil
	2nd year		2.00
	3rd year		4.00
	4th year		6.00
Rabi seasonal crops other than wheat	1st year		Nil
	2nd year		2.66
	3rd year		5.33
	4th year		8.00
Hot weather seasonal crops such as sann-hemp clover, bursem lucern and other fodder crops	1st year		Nil
	2nd year		5.33
	3rd year		5.33
	4th year		5.33
	5th year		10.66
	6th year		10.66
	7th year		10.66
	8th year		16.00
		Major projects	Other projects (i.e. minor and medium projects). Two third rates of major projects
Garden crop & vegetables and any other fruit crop	1st year	13.33	8.88
	2nd year	20.00	13.33
	3rd year	26.66	17.77
	4th year	33.33	22.22

Appendix 10.4—*Contd.*

Crop		Major Projets Rs.	Other projects (i.e. minor and medium projects Two third rates of major projects Rs.
	5th year	40.00	26.66
	6th year	53.33	35.35
	7th year	66.66	44.44
	8th year	80.00	53.53
	9th year	93.33	62.22
	10th year	106.66	70.77
	11th year	120.00	80.00
Sugarcane	1st year	20.00	13.33
	2nd year	30.00	20.00
	3rd year	40.00	26.66
Pan, plantains & mulberry	4th year	50.00	33.33
	5th year	60.00	40.00
	6th year	80.00	53.33
	7th year	100.00	66.66
	8th year	120.00	80.00
	9th year	140.00	93.33
	10th year	160.00	106.66
	11th year	180.00	120.00
L.S. Cotton	1st year		Nil
	2nd year		7.33
	3rd year		9.33
	4th year		14.33
	5th year		16.66
	6th year		16.66
	7th year		16.66
	8th year		22.00
Groundnut (hot weather)	1st year		Nil
	2nd year		5.33
	3rd year		5.33
	4th year		10.66
	5th year		10.66
	6th year		10.66
	7th year		10.66
	8th year		16.00
Groundnut (kharif)	1st year		Nil
	2nd year		2.00
	3rd year		4.00
	4th year		6.00

Note: First year referred to relates to the Irrigation year 1967-68.

* The rate is applicable to agreement areas while for demand it should be double the rate applicable for agreement areas.

APPENDIX 10.5

Water Rates Prevailing in the Marathwada From 1.7.1967

Crop		Rate	
1		2	
		Major project (i.e. project costing Rs. 20 million and above)	Other project (i.e. medium & minor project). (2/3rd of rates for major project)
		Rs.	Rs.
Heavy perennials	1st year	20.00	13.33
	2nd year	30.00	20.00
	3rd year	40.00	26.66
	4th year	50.00	33.33
	5th year	60.00	40.00
	6th year	80.00	53.33
	7th year	100.00	66.66
	8th year	120.00	80.00
	9th year	140.00	93.00
	10th year	160.00	106.66
	11th year	180.00	120.00
Light perennials	1st year	13.33	8.88
	2nd year	20.00	13.33
	3rd year	26.66	17.77
	4th year	33.33	22.22
	5th year	40.00	26.66
	6th year	53.33	35.35
	7th year	66.66	44.44
	8th year	80.00	53.53
	9th year	93.33	62.22
	10th year	106.66	70.77
	11th year	120.00	80.00

Major, medium and minor project

Kharif		Rabi
Rs.		Rs.
Nil	1st year	Nil
2.00	2nd year	2.66
4.00	3rd year	5.33
6.00	4th year	8.00

Appendix 10.5—*Contd.*

Major project (i.e. project costing Rs. 20 million and above)

Hot weather		Pre-seasonal		Post-seasonal		Two-seasonal	
1st year	Nil	1st year	Nil	1st year	Nil	1st year	Nil
2nd year	5.33	2nd year		2nd, 3rd		2nd year	5.00
3rd & 4th yr.		3rd yr. &	2.66	& 4th yr.	1·00	3rd year	10.00
5th, 6th &		4th yr.		5th, 6th		4th year	15.00
7th year	10.66	5th, 6th		& 7th yr.	2.00		
8th year	16.00	& 7th yr.	5.33	8th yr.	3.00		
		8th yr.	8.00				

(*Note:* First year referred to relates to the irrigation year 1967-68.)

APPENDIX 10.6

Water Rates on Lift Irrigation on Canal, Notified Rivers, Nallas, Tubewells etc.

	On Notified Nallas, Rivers etc.		On lift on canal	On Tubewells
(1) By flow	Full canal flow rate		Full canal flow rate	Re. 1/- for 10,500 gallons of water for food and cash crops. An additional slab rate of Rs. 20/- per acre for cotton.
(2) By lift	Up to 45′ ft. height	Above 45′ height	Lift irrigation between Dam and pick-up weir	
(1) Cane	Rs. 60/- per acre per year	Rs. 40/- per acre per year	Half the flow rate	
(2) Other perennials	Rs. 30/-	Rs. 25/-	Beyond back water zone on the main river and its tributaries up-stream of the dam and pick up weir.	An additional slab rate of Rs. 25/- per acre for fruit garden and all other cash crops which require more than 5 waterings. An additional slab rate of Rs. 8/- per acre for individual vegetable crops. Perennials i.e. sugarcane, plantains and pan garden and also paddy is not to be allowed on tube-wells.
(3) Two seasonals	Rs. 6/-	Rs. 6/-		
(4) Food and fodder crops	Free of charge if prior permission of the Deptt. is obtained.		(1) Cane : 25 per cent of the canal flow rate. (2) o.p. : -do- (3) T.S. crops : 50 per cent of the canal flow rate. (4) Food and fodder crops/kharif & rabi Free of charge if permission is obtained.	

APPENDIX 10.7

Rate of Irrigation Cess Adopted in Western Maharashtra

(Rs. per acre per annum)

	Rates of irrigation cess levied on various crops since 1954 to 15.2.1961	Rates of irrigation cess levied on various crops since 15.2.1961 and continued 30.6.1970
Sugarcane and equivalent crops	22.50	30.00
Other Perennial crops	11.25	15.00
Sugarcane (for 1 or 2 seasons)	7.50	10.00
Other Perennials (for 1 or 2 seasons)	4.00	5.00
Eight months blocks	2.50	3.00
Crops other than those mentioned above	2.50	3.00

APPENDIX 13.1

Drought Affected Taluks in Mysore

(I) *Chitradurga District*
- (1) Challakere
- (2) Hiriyur
- (3) Davangere
- (4) Molakalmuru
- (5) Jagalur
- (6) Hosadurga
- (7) Chitradurga
- (8) Holalkere

(II) *Dharwar District*
- (9) Ron
- (10) Gadag
- (11) Ranibennur
- (12) Mundargi

(III) *Bangalore District*
- (13) Hoskote
- (14) Dod Ballapur
- (15) Nelamangala
- (16) Kanakapura
- (17) Magadi
- (18) Ramanagaram
- (19) Anekal
- (20) Devanahally
- (21) Channapatna

(IV) *Hassan District*
- (22) Channarayapatna
- (23) Arsikere
- (24) Holenarsipur

(V) *Gulbarga District*
- (25) Shahapur
- (26) Yadgir
- (27) Chincholi
- (28) Sedam
- (29) Gulbarga
- (30) Aland
- (31) Afzalpur
- (32) Chitapur
- (33) Jeevargi
- (34) Shorapur

(VI) *Kolar District*
- (35) Srinivaspur
- (36) Gudibanda
- (37) Chickaballapur
- (38) Gauribidanur
- (39) Bagepally
- (40) Kolar
- (41) Bangarpet
- (42) Chintamani
- (43) Mulbagal
- (44) Malur

(VII) *Raichur District*
- (45) Lingasugur
- (46) Deodurga
- (47) Yelburga
- (48) Kustagi
- (49) Koppal

(VIII) *Tumkur District*
- (50) Madhugiri
- (51) Sira
- (52) Turuvekere
- (53) Tiptur
- (54) Kunigal
- (55) Pavagada
- (56) Chiknayakanhalli
- (57) Koratagere
- (58) Gubbi

(IX) *Bellary District*
- (59) Bellary
- (60) Siruguppa
- (61) Hadagali
- (62) Kudligi
- (63) Harapanahalli
- (64) Mallapuram
- (65) Hospet
- (66) Sandur

(X) *Mysore District*
- (67) Chamarajanagar
- (68) Hunsur
- (69) Gundulupet
- (70) Nanjangud
- (71) T. Narsipur
- (72) Periyapatna
- (73) Kollegal

Appendix 13.1—*contd.*

(XI) *Mandya District*
- (74) Malavalli
- (75) K. R. Pet
- (76) Nagamangala
- (77) Pandavapura

(XII) *Bijapur District*
- (78) Bijapur
- (79) Indi
- (80) Sindgi
- (81) Bagewadi
- (82) Jamakhandi
- (83) Bilgi
- (84) Muddebihal
- (85) Mudhol
- (86) Bagalkot
- (87) Hungund
- (88) Badami

APPENDIX 13.2

Irrigation Works under Construction in Drought Areas

Project	Districts benefited	Continuing from	Irrigation benefits (Thousand hectares)
1	2	3	4
Hathikoni Dam	Gulbarga	I Plan	2.14
Upper Krishna Stage I	Bijapur, Raichur & Gulbarga	III Plan	242.82
Rajolibanda Diversion	Raichur	I Plan	2.38
Kanakanala	Raichur	II Plan	2.06
Tungabhadra High Level Canal Stage I & II	Bellary	I Plan/ Annual Plan	80.94
Hagaribommanahalli	Bellary	II Plan	2.97
Kabini	Mysore	II Plan	50.99
Chickhole	Mysore	II Plan	1.60
Hebbahalla	Mysore	II Plan	1.21
Arakavathi	Bangalore	Annual Plan	2.83
Hemavathi	Hassan & Mandya	—	—
Chandrampalli	Gulbarga	—	5.00

APPENDIX 13.3

Irrigation Works Proposed by Mysore State Government which will benefit the Drought Areas

Name of project	Drought-district benefited	Irrigation benefits (Thousand hectares)
1	2	3
Lower Mullamari	Gulbarga	12.95
Gandhorinalla	,,	9.31
Amarja Dam	,,	7.28
Bhima Lift Irrigation	,,	83.97
Bhima Irrigation	,,	81.54
Kagna	,,	25.90
Bennithore	,,	20.23
Balkundi	Bijapur	1.28
Bijapur Lift Irrigation	,,	242.81
Don	,,	8.09
Ranga Samudra	,,	1.00
Ramthal Irrigation	,,	27.32
Arjanala	,,	1.72
Almol	,,	1.44
Upper Krishna Stage II	Gulbarga, Bijapur & Raichur	269.92
Maskinala	Raichur	2.43
Tungabhadra Foreshore lift irrigation	Raichur & Bellary	23.62
Hirehalla	Raichur	2.49
Tungabhadra Diversion	Raichur & Bellary	60.70
Nari Halla	Bellary	4.59
Feeder Canal to Dharampur Tank	Chitradurga	2.02
Feeder Canal to Ranikere Tank	,,	4.35
Jinegehalla	,,	1.21
Madagamasur Dam	Dharwar	8.50
Mundwad	,,	1.46
Hulikere	,,	1.17
Veerapur Anicut	,,	1.36
Upper Bhadra Dam	Chitradurga & Bellary	105.22
Changavadi	Mysore	2.63
Sagore Doddakere	,,	0.81
Belthur	,,	1.42
Survarnavathy	,,	6.76
Doddihalla	,,	1.21
Gundal	,,	4.05
Taraka	,,	7.35
Kuduregundihalla	,,	0.89
Minnathuhalla	,,	1.21

Appendix 13.3—*contd.*

1	2	3
Uduthorehalla	Mysore	62.73
KRS Right Bank H. L. C.	Mysore & Mandya	20.23
Hemavathi Stage II	Mandya, Hassan & Tumkur	141.64
Iggulur Anicut	Mandya & Bangalore	3.24
Manchanabele	Bangalore	2.83
Votehole	Hassan	5.26
Yagachi	,,	12.95
Uttarapinakini	Tumkur	1.46
Marconahalli Extension	,,	2.02

APPENDI

Salient Features of Projects Irrigatin

Sl. No.	Name of Project	Source of water	Storage/ non-storage	Capital cost (Rs. million)	Year of completion	Type
1	2	3	4	5	6	7
A.	***COMPLETED PROJECTS (BY MARCH, 1969)***					
I.	*Pre-plan Projects*					
1.	Orissa Canals System	Mahanadi Brahmani Baitarani	Diversion	27.66	1895	Anicut
2.	Rushikulya Canal System	Padma Rushikulya	Diversion +Storage	5.61	1901	N.A.
3.	Mehendratanaya System	N.A.	N.A.	1.09	N.A.	N.A.
II.	*First, Second and Third Plan Projects*					
B.	***PROJECTS UNDER CONSTRUCTION***					
I.	*First Plan Projects*					
1.	Hirakud Project	Mahanadi	Storage St. I St. II	 678.10 148.50	IV Plan	Earth Masonry Concrete
2.	Mahanadi Delta Irrigation	Mahanadi	Diversion	683.81	IV Plan	Weir
II.	*Second Plan Projects*					
3.	Salandi	Salandi	Storage/ Diversion	129.77	IV Plan	Composite dam
4.	Salia	Salia	Storage	29.40	IV Plan	Earthen
5.	Salki	Salki	Diversion	16.60	,,	Anicut
6.	Godahado	Godahado	Storage	19.85	,,	Earthen
7.	Dhanai	Dhanai	Storage	13.21	,,	,,

15.1

4,050 hectares and Above*

Max. ht. (metres)	Length (metres)	Storage capacity m.cu.m.		Full supply discharge (cumecs)	C.C.A. (hecs.)	Gross area to be irrigated (hecs.)	Remarks
		Gross	Live				
8	9	10	11	12	13	14	15
—	—	—	—	—	—	111,351	
—	—	—	—	—	—	48,000	
N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	4,047	
	—NIL—						
61	Earth 3,852 Masonry & Concrete 1,148 20,656 .. Dykes	8,141	5,822	Bargarh Canal 136 Sason Canal 18 Sambalpur Disty. 3.6	153,780	242,810	
—	1,332	—	—	Main Puri Canal 170	408,730	679,870	Includes existing irrigation
52	817	566	557	N.A.	—	61,917	
28	445	51	N.A.	N.A.	—	10,830	
—	129	—	—	N.A.	—	21,850	
24	1,667	N.A.	N.A.	N.A.	N.A.	6,475	
16	N.A.	N.A.	8	N.A.	N.A.	5,261	

Appendix

Sl. No.	Name of Project	Source of water	Storage/ non-storage	Capital cost (Rs. million)	Year of completion	Type
1	2	3	4	5	6	7
8.	Darjang	Nisgra & Matalia	Storage	37.24	IV Plan	Earthen
III.	*Third Plan Projects*					
9.	Pitamahal	Pitamahal	,,	8.30	,,	,,
10.	Bahuda St. I	Bahuda Poichodia Bartada Baginala	Storage/ Diversion	15.89	N.A.	N.A.
11.	Hiradharbatti	Rushikulya	,,	3.40	IV Plan	Anicut
IV.	*Annual Plan Projects (1966-69)*					
12.	Uttai	Uttai	Diversion	9.02	IV Plan	Weir
13.	Baghna	Baghna	,,	6.56	,,	,,
14.	Dahuka	Dahuka	,,	5.61	,,	,,

15.1—*contd.*

Max. ht. (metres)	Length (metres)	Storage capacity m.cu.m.		Full supply discharge (cumec)	C.C.A. (hecs.)	Gross area to be irrigated (hecs.)	Remarks
		Gross	Live				
8	9	10	11	12	13	14	15
27	N.A.	48	N.A.	N.A.	N.A.	8,712	
23	703	N.A.	N.A.	N.A.	N.A.	4,856	
N.A.	N.A.	Bahuda 71	45	N.A.	N.A.	10,562	
		Poichodia	29				
		Bartada	13				
		Baginala	38				
N.A.	N.A.	—	—	N.A.	N.A.	5,858	
—	53	N.A.	N.A.	N.A.	N.A.	11,331	
—	99	—	—	N.A.	N.A.	4,047	
—	152	—	—	N.A.	N.A.	4,654	

**Source*: (1) State Replies to Irrigation Commission.
(2) Irrigation Statistics of India (1960-61)—CW&PC
(3) Irrigation & Power Projects (1970)—CW&PC
(4) Note Volume of Irrigation Chapter—Orissa (July 1969)—CW&PC

Note NA—Not Available.

APPENDIX

Salient Features of Projects Irrigatin[g]

Sl. No.	Name of project	Source of water/ Name of river	Storage/ non-storage	Capital cost (Rs. million)	Year of comple-tion	Type
1	2	3	4	5	6	7
1.	Upper Bari Doab Canal	Ravi	Non-storage	25.38	1878-79	Canal
2.	Sirhind Canal	Sutlej	,,	27.53	1886-87	Canal
3.	Eastern Canal	,,	,,	24.98	1933	Canal
4.	Shah Nahar Canal	Beas	,,	3.32	1951	Canal
5.	Kiran Nallah	N.A.	,,	1.48	1955-56	Canal
6.	Extension of irrigation to arid areas of Jandiala and Gurdaspur Dn. of UBDC	Ravi	,,	1.33	1955-56	Canal
7.	Raising and strengthening of banks of channels	—	,,	11.49*	1955-56	Canal
8.	Harike Project	Sutlej	,,	91.45	1957-58	Barrage
9.	Extension of distributaries of Kasur Branch	Ravi	,,	2.33	1959-60	Canal
10.	Bhakra Nangal Project	Sutlej	Storage	805.87	1963-64	R.C.C. Dam

Source (1) Irrigation Statistics of India 1960-61, CW&PC—March, 1968
(2) India—Irrigation and Power Projects, CW&PC—April, 1970
(3) Note Volume of Irrigation Chapter on Punjab, CW&PC—March, 1970.

4,000 Hectares and Above

Max. height (metres)	Length (metres)	Storage capacity m.cu.m.		Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irri-gated (hectares)	Remarks
		Gross	Live				
8	9	10	11	12	13	14	15
—	—	—	—	254	490,091	367,921	
—	—	—	—	357	1,507,504	1,031,001	
—	—	—	—	94	147,536	107,826	
—	—	—	—	15	20,639	21,788	
—	—	—	—	N.A.	N.A.	7,040	
—	—	—	—	N.A.	N.A.	6,780	
—	—	—	—	N.A.	N.A.	7,280	*Including Haryana
—	—	—	—	N.A.	N.A.	27,400 13,800	
—	—	—	—	N.A.	N.A.	37,480	
226	518	9,867.8	7,770.9	354	N.A.	532,250	

APPENDIX 17.1

Average Annual flows of Rivers of Rajasthan

River	Average flow in	
	m.cft.	m.cum.
1	2	3
I. BANAS RIVER VALLEY		
Banas I (from its source to Khakhunda)		
1. Kothari river basin	6,644	188.03
2. Banas up to Khakhunda	20,203	571.74
3. Berach river basin	30,589	865.67
Total	57,436	1,625.44
Banas II (from Khakhunda to its confluence with Chambal)		
1. Khari river	16,478	466.33
2. Dai river	4,719	133.55
3. Mashi river	7,666	216.95
4. Shodra river	4,715	133.43
5. Dhil river	1,511	42.76
6. Morel river	14045	397.47
7. Kalisil river	2,174	61.52
8. Main Banas river	32,433	917.85
Total	83,741	2,369.86
II. MAHI RIVER VALLEY		
1. Jakham river	27,378	774.80
2. Som river	73,655	2,084.44
3. Moran river	3,956	111.95
4. Anas river	69,370	1,963.17
5. Mahi river	123,089	3,483.42
6. Bhadar & Vatrak river	5,384	152.37
Total	3,02,839	8,570.15
III. CHAMBAL RIVER VALLEY		
1. Chambal river	18,433	521.65
2. Chakhan river	1,822	51.56
3. Mej river	22,833	646.17
4. Eru river	2,233	63.19
5. Alnia river	3,590	101.60
6. Parbati river	35,310	999.27
7. Kunu river	4,350	123.10
8. Parwan river	20,478	579.53
9. Kalisindh river	42,760	1,210.11
ABOVE KOTA BARRAGE		
1. Chambal river	—	—
2. Choti Kalisindh	1,796	50.83
Total	1,53,605	43,47.01

Appendix 17.1—*Contd.*

River	Average flow in m.cft.	Average flow in m.cum.
1	2	3
IV. SABARMATI RIVER VALLEY		
1. Wakal river	15,683	443.83
2. Sabarmati river	2,036	57.62
3. Sei river	6,592	186.55
Total	24,311	688.00
V. MISC. RIVERS		
1. Sabi river valley	6,100	172.63
2. Baran river valley	5,770	163.29
3. Banganga river valley	16,472	466.16
4. Gambhir river valley	15,566	440.52
5. Parbati river valley	7,780	220.17
6. West Banas river valley	8,860	250.74
7. Sukli river valley	2,274	64.35
8. Other Nallah of Jalore	493	13.95
Total	63,315	1,791.81
VI. LUNI RIVER VALLEY		
1. Jojri river	2,004	56.71
2. Luni (origin to Jaswant Sagar)	3,750	106.12
3. Luni (Jaswant Sagar to Nakoda)	2,974	84.16
4. Luni (Nakoda to Chitalwana)	494	13.98
5. Guniya river	3,352	94.86
6. Sukri Hemawas	1,541	43.61
7. Bandi Hemawas	1,579	44.69
8. Sukri (Bankli to Luni)	1,181	33.42
9. Sukri (Up to Bankli)	351	9.93
10. Mithri river	1,373	38.86
11. Jawai river	6,338	179.36
12. Sukri (Up to Luni)	317	8.97
13. Khari (Up to Luni)	2,834	80.20
14. Bandi river	959	27.14
15. Sagi river	351	9.93
Total	29,398	831.94
VII. RIVERS OF SHEKHAWATI AREA		
1. Kantli river	2,987	84.53
2. Dohan river	1,239	35.06
3. Nawalgarh Nallah	167	4.73
4. Krishnawati river	378	10.70
5. Ranoli river	483	13.67
6. Mehdha river	4,672	132.22
Total	9,926	280.91
Grand Total	7,24,571	20,505.12

APPENDIX 17.2

Salient Features of Projects Irrigating 4,000 Hectares and Above

Sl. No.	Name of Project	Source of water/ Name of river	Storage/ non-storage	Capital cost (Rs. million)	Year of completion	Type	Length (metres)	Maximum height (metres)	Storage capacity (m.cu.m.) Gross	Storage capacity (m.cu.m.) Live	Full Supply Discharge (cumecs)	C.C.A. (hectares)	Gross area irrigated annually (average in hectares)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Jai Samand Tank	Gumti & Jamari	Storage	6.00	1910	Tank	122	7.6	—	566	0.25	5,058	4,050	Canal extended in 1953
2.	Gang Canal	Sutlej	Non-storage	33.20	1927	Canal	—	—	—	—	73.44	307,660	257,500	
3.	Jaswant Sagar	Luni	Storage	0.95	—	Tank	—	—	—	—	—	6,475	5,000	
4.	Parvati Pick-up weir	Parvati	Non-storage	—	—	Weir	—	—	—	—	—	9,270	7,990	
5.	Jawai	Jawai	Storage	25.00	1951	Masonry	871	34	—	182	10.80	41,274	7,690	
6.	Morel	Morel	,,	5.00	1954	Earth dam with masonry core wall	4,200	15.60	—	70	51.30	19,233	7,452	
7.	Meja	Kothari	,,	9.70	1956	Earthern	4,500	18	—	90	8.10	16,370	8,400	
8.	Sareri	Mashi	,,	3.90	1957	,,	5,160	11.89	—	54	48.60	6,200	5,400	
9.	Khari	Khari	,,	3.70	1957	,,	1,515	17.40	—	29	29.70	8,200	4,900	
10.	Namona	Banas	,,	5.80	1957	Earth dam with masonry over flow	1,350	18.90	—	21	32.40	8,084	4,099	
11.	Gudha	Mej	,,	7.20	1957	Earthen	2,760	25	—	120	5.40	12,141	6,070	
12.	Parvati	Parvati	,,	12.20	1959	Masonry	7,515	32	—	114	9.46	24,000	12,000	
13.	Galwa	Banas	,,	4.10	1960	Earth dam with masonry over-flow	4,700	16.50	—	47	43.20	10,805	4,451	
14.	West Banas	West Banas	,,	6.50	1968	Earthen	4,084	—	—	—	—	5,188	4,470	
15.	Bharatpur Feeder	Yamuna	Non-storage	1.70	1970	Canal	—	—	—	—	—	10,600	6,000	
16.	Bhakra Canals (Rajasthan portion)	Sutlej	Storage	234.00	1964	Gravity dam in Himachal Pradesh	—	—	—	—	68.31	370,000	150,700	
17.	Chambal Stage I & II	Chambal	Storage	192.90*	1967		600.54	37	—	—	214	373,000	74,000	*Rajasthan share
18.	Rajasthan Canal	Sutlej and Beas	Storage	1,102.00	—		—	—	—	—	523.55	1,150,000	37,700	Under construction

Source: (1) Irrigation Statistics of India 1960-61, CW&PC—March, 1968.
(2) Note volume of Irrigation Chapter—Rajasthan, CW&PC—March, 1970.
(3) Draft Replies to the Irrigation Commission Questionnaire—Rajasthan Government, Feb., 1970.

APPENDIX 17.3

Water Rates in Different Projects in Rajasthan

1. *Ganga Nagar Project (Perennial & Non-perennial Channels)*

		Rs. per hec. (acre)
(a)	*Kharif*	
	(i) Rice	21.00 (8.50)
	(ii) Waternuts	24.09 (9.75)
	(iii) Cotton	15.44 (6.25)
	(iv) Indigo & other dyes, tobacco, spices & drugs orchards; vegetables other than turnips (except zeera)	16.68 (6.75)
	(v) Maize, melon, fibres other than cotton	14.83 (6.00)
	(vi) Bajra, jowar, guara, pulses, fodder, crops chana & grass with two or more waterings	9.88 (4.00)
(b)	(i) Wheat	12.97 (5.25)
	(ii) Barley, oats, bajra and gochani	14.83 (6.00)
	(iii) Gram	9.88 (4.00)
	(iv) All other rabi crops not otherwise specified including oilseeds	12.97 (5.25)
	(v) Watering for ploughing not followed by a crop (Pelwar & single watering for grass)	3.71 (1.50)
	(vi) All rabi crops,	7.41 (3.00)
	1st watering	
	2nd watering	
	3rd watering	7.41 (3.00)
	or more waterings	Same rates as for perennial channels.
	(vii) Watering for ploughing not followed by a crop (Pelwar)	3.71 (1.50)
	(viii) Zeera	19.15 (7.75)
(c)	*Perennial*	
	(i) Sugarcane	40.16 (16.25)
	(ii) Gardens	20.39 (8.25)

Remarks: The rate for lift & seepage irrigation is half the rate of flow irrigation.

2. *Bhakra Project & Ghaggar Canal Areas*
(Perennial and non-perennial)

		Rs. per hec. (acre)
(a)	*Kharif*	
	(i) Rice	22.24 (9.00)
	(ii) Maize	16.06 (6.50)
	(iii) Cotton	19.15 (7.75)
	(iv) Jowar, gowar and other fodder crops	9.88 (4.00)
	(v) Vegetables & spices (except zeera)	20.39 (8.25)
	(vi) Hemp and Grass	9.88 (4.00)
	(vii) All other kharif	15.74 (6.37)
	(viii) Zeera	22.86 (9.25)

Appendix 17.3—*Contd.*

(b) *Rabi*	
(i) Wheat, barley	14.83 (6.00)
(ii) Gram	9.88 (4.00)
(iii) Rabi oil crops	15.74 (6.37)
(iv) For rabi crops (non-perennial irrigation)	
1st watering	7.41 (3.00)
2nd watering	7.41 (3.00)
3rd watering	Perennial rates
(v) For irrigation water taken for ploughing and not followed by any crop	
1st watering	7.41 (3.00)
2nd watering	12.36 (5.00)
3rd watering	Perennial rates
(c) *Perennial*	
(i) Sugarcane	40.77 (16.50)
(ii) Gardens	20.39 (8.25)

General Remarks: The rate for lift irrigation is half the rate for flow irrigation.

3. *Rates chargeable on all irrigation done from (a) all works which have been constructed after the 1st Jan. 1952 other than from Gang Canal, Bhakra supplies and (b) from all works in the area of the former States of Banswara, Dungarpur and Pratap Garh.*

	Rs. per hec. (acre)
1. Sugarcane	54.36 (22.00) per year
2. Vegetable singhara	29.65 (12.00) per crop
3. Gardens	29.65 (12.00) per half year
4. Lucerne, tobacco and poppy	24.71 (10.00) per crop
5. Rice	21.00 (8.50) per crop
6. All other crops except zeera	17.30 (7.00) per crop
7. Palewa not followed by crop	9.88 (4.00) for all crop
8. Wheat	24.71 (10.00) per crop
9. Zeera	19.27 (8.00) per crop
10. Cotton	19.27 (8.00) per crop

	Rs. per hec. (acre)
4. *Gang Canal*	
Kharif & rabi	13.98 (5.66)
5. *Bhakra*	
Kharif & rabi	21.00 (8.50)
6. *Chambal*	
Kharif & rabi	21.00 (8.50)
7. *Jawai*	
Rabi	21.62 (8.75)
8. *Meja*	
Rabi	21.62 (8.75)
9. *Parbati*	
Rabi	21.62 (8.75)
10. *Gudha*	
Rabi	21.62 (8.75)
11. *Gambheri*	
Rabi	21.62 (8.75)

APPENDIX 18.1

Salient Features of Projects Irrigating 4,050 Hectares and Above

Sl. No.	Name of project	Source of water/ Name of river	Storage/ Diversion	Type	Capital cost (Rs. million)	Year of completion	Length (Metres)	Max. height (Metres)	Storage capacity Gross (m.cu.m.)	Storage capacity Live	Full supply discharge (cumecs)	C.C.A. (Hectares)	Gross area to be irrigated (Hectares)	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. *COMPLETED PROJECTS (BY MARCH, 1969):*														
I. *Pre-Plan Projects*														
1.	Cauvery Delta System	Cauvery	Weir	NA	10.33	1889	293	—	—	—	566.3	367,877	366,000	
2.	Lower Coleroon Anicut	Coleroon	Weir	NA	3.43	1903	711	—	—	—	37.6	44,473	44,450	
3.	Cauvery-Mettur Project	Cauvery	Dam	Masonry	66.36	1934	1,615	65	2,925 (including flood storage)	2,648	104.3	201,212	134,000	
4.	Periyar System	Periyar & Vagai	Dam	,,	10.84	1897	378	54	—	300	45.3	57,870	57,700	
5.	Palar Anicut	Palar	Weir	NA	2.58	1896	801	—	—	—	68.6	42,505	33,600	
6.	Srivaikuntam Anicut	Tambraparni	Weir	NA	1.78	1889	116	—	—	—	9.4	13,557	10,500	
7.	Tadepalli Channel System	NA	NA	—	0.19	NA	NA	—	—	—	NA	NA	7,670	
8.	Kalingarayan Channel System	Cauvery	Diversion	—	0.18	NA	NA	—	—	—	NA	NA	5,660	
9.	Chembrampakkam Tank	Palar basin	Storage	NA	0.76	NA	NA	NA	NA	NA	NA	NA	6,050	
10.	Poiney Anicut	Poiney	Weir	NA	0.30	NA	NA	—	NA	NA	NA	NA	9,690	
11.	Cheyyar Anicut	Cheyyar	Weir	NA	1.04	1896	71	—	—	—	43.9	11,922	9,690	

Appendix 18.1—*contd.*

Sl. No.	Name of Project		Source of water	Storage/ Non-storage	Capital cost (Rs. million)	Year of completion	Type	Max. height (metres)	Length (metres)	Storage capacity (m.cu.m.) Gross	Storage capacity (m.cu.m.) Live	Full Supply Discharge (Cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
1	2		3	4	5	6	7	8	9	10	11	12	13	14	15
12.	Tirnkoibur Anicut	Ponnaiyar	Weir	NA	0.42	NA		NA	—	—	—	NA	NA	11,300	
13.	Shatiatope Anicut	Vellar	Weir	NA	1.09	1895		161	—	—	—	24.1	17,792	13,720	
14.	Vridhachalam Anicut	Manimuktanadi	Weir	NA	0.11	NA		NA	—	—	—	NA	NA	4,050	
15.	Marudur Anicut	Tambraparni	Weir	NA	0.06	NA		—	—	—	NA	NA	—	8,480	
16.	Kattalai Scheme	Cauvery	Diversion	NA	0.42	1926		1,288	—	—	—	46.4	30,341	29,100	
17.	Wellington Reservoir	NA	NA	,,	0.26	NA		NA	NA	NA	NA	NA	NA	11,300	
18.	Palandorai Anicut	Vellar	Weir	,,	0.69	NA		NA	NA	—	—	NA	NA	6,450	
19.	Tholudur Reservoir	Vellar	Weir/tank	,,	0.62	1925		NA	NA	—	73	11.9	11,655	NA	
II. First, second and third plan projects															
1.	Lower Bhavani	Bhavani	Storage	Composite	103.40	1956		8,799	62	925	900	65.1	131,525	78,920	
2.	Kodayar Extension (Perinchane)	Kodayar	Dam	Masonry	4.37	,,		NA	—	—	—	NA	NA	47,530	
3.	Thiruparapu Weir	Kodayar	Weir		2.29	,,									
4.	Manimuthar	Mani-Muthar	Dam	Composite	50.50	1958		3,398	46	155	155	12.6	NA	41,690	
5.	Amaravathy	Amravathy	,,	,,	33.41	1959		1,095	50	NA	115	8.5	17,000	21,650	
6.	Sathanur I	Penniar	Dam	,,	25.80	1958		786	41	NA	130	11.5	8,505	8,500	
	II	,,	,,	Addition of gates	6.00	1966								2,020	

Appendix 18.1—*contd.*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7.	Methur Canals	Cauvery	Canal	Canal	19.29	1957	—	—	—	—	11.5	18,225	18,250	
8.	Vaigai Project	Periyar & Vaigai	Dam	NA	33.00	1959	3,559	37	NA	193	5.9	16,243	9,240	
9.	New Kattalai H.L. Canal	Cauvery	Canal	Canal	22.46	1960	—	—	—	—	31.4	8,340	8,340	
10.	Pullambadi Canal	,,	,,	,,	20.59	1960	—	—	—	—	32.0	8,950	8,950	
B.	*PROJECTS UNDER CONSTRUCTION*													
I.	*First plan projects*								NIL					
II.	*Second plan projects:*													
1.	Parambikulam Aliyar Project	Nirar, Sholayar, Parambikulam, Tunacadavu, Peruvaripallam, Aliyar, Palar	Storage		675.3	IV Plan (anticipated)			Details given elsewhere in the text			NA	97,130	
III.	*Third plan projects*													
2.	Chittar Pattanam kal.		Dam	Earthen	73.3	IV plan	762	22	16	11	NA	NA	19,020	
IV.	*Annual plan projects (1966-69) and IV plan projects*													
3.	Modernising Vaigai Channels	Vaigai	Diversion		39.4	IV plan (Probable)	—	—	—	—	—	—	4,445	
4.	Modernising Tanjavoor Canals	Cauvery	Improvement to existing works		225.0	V Plan (Probable)		—	—	—	—	—	57,895 (not yet approved by Planning Commission)	

**Source:* CW&PC—Irrigation Statistics of India (1960-61)
CW&PC—Irrigation and Power Projects (1970)
CW&PC—Note Volume of Irrigation Chapter Tamil Nadu (March, 1970).

APPENDIX 18.2

Schedule of Water Rates

Sl. No.	Name of Project	Crop	Rate (Rs. per acre)	Remarks
1	2	3	4	5
1. 2. 3.	Lower Bhavani Amaravathy Mettur Canals	Cotton, Yarn, Castor, Plantain, Coconut Fruit trees	20.00	In the case of Lower Bhavani and Amaravathy projects, concessional water rates were given as follows: ½ of the rates for the first year of issue of permit, ¾ of the rates in the second year and full rates thereafter.
		Paddy, Chillies, Tobacco, Onion, Sweet Potato, Turmeric, Tapioca, Vegetables	15.00	In the case of Mettur Canals, half the rates were charged for Fasli 1364, 1,365 and 1,366 if irrigation was for the first time in the case of right bank canal; and for Fasli 1,366, 1,367 & 1,368 if irrigation was for the first time in case of left bank canal.
		Groundnut, Gingelly, Millets, Pulses, Fodder Crop	10.00 7.50	
4.	Manimuthar	All crops in Delta area	12.50	All tanks which are fed by the reservoir are provisionally ordered to be classified as Class I source for levy of assessment.
		All crops in non-Delta area	10.00	
5.	Vaigai (Madurai Distt.)	1st wet crop	10.00	During the first year, no charge was levied for water used to convert dry lands into wet, unless a crop was grown.
		2nd wet crop	10.00	
		3rd wet crop	10.00	
		1st dry crop (systematically irrigated)	10.00	

Appendix 18.2—*contd.*

Sl. No.	Name of Project	Crop	Rate (Rs. per acre)	Remarks
1	2	3	4	5
		2nd dry crop	10.00	For the first crop raised after conversion, only half the rates are charged.
		1st, 2nd & 3rd dry crops (occasionally irrigated)	5.00	
		Sugarcane, Turmeric and Crops standing more than 6 months	20.00	Existing wet rates increased by Rs. 10.00 per acre (Revised rates are Rs. 14.37 per acre).
	Vaigai (Ramanathapuram Distt.)	1st wet crop, 2nd wet crop, 3rd wet crop	5.00	
		Dry crops	5.00	
		Sugarcane & Crops standing more than 6 months	10.00	,,

Note: Existing wet rates increased by Rs. 5.00 per acre.

Sl. No.	Name of Project	Crop	Rate (Rs. per acre)	Remarks
6.	Parambikulam Aliyar	Wet crops	25.00	1/3 rate in the first year of irrigation. 2/3 rate in the 2nd year of irrigation and full rates from third year onwards.
		Dry crops	15.00	
7.	*Cauvery System*			
	(i) Cauvery-Mettur Project	*Ryatwari dry lands*		
		1st crop	10.00	
		2nd crop	5.00	
		3rd crop	2.50	
		Duffasal crop	15.00	
		Ryatwari wet lands		
		1st crop	—	
		2nd crop	5.00	
		3rd crop	—	
		Duffasal	5.00	

Appendix 18.2—*contd.*

1	2	3	4
(ii) New Kattlai High Level Canal (iii) Pullambadi Canal	1st crop 2nd crop 3rd crop Duffasal crop	10.00 5.00 2.50 15.00	Water cess at half rates levied for the first five years and subsequently full rates.

Note: Tanks fed by these two canals have been classified as Class I sources for purposes of levy of wet assessment.

1	2	3	4
8. Chittar Pattanamkal	Paddy, Chillies Tobacco, Onions, Sweet Potato, Turmeric, Tapioca and Vegetables	20.00	1/5 rate for the first year. 2/5 rate for the 2nd year. 3/5 rate for the 3rd year, 4/5 rate for the 4th year and full rate for the fifth year and thereafter.
	Cotton, Coconut, Fruit trees, Plantain, Yams and Castor	25.00	
	Groundnut Gingelly	15.00	
	Millets, Pulses and Fodder Crops	10.00	

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APPENDIX

Salient Features of Projects Irrigating

Name of Project	Source of water	Storage/ Diversion	Capital cost (Rs. million)	Year of completion	Storage	
					Type	Max. height (metres)
1	2	3	4	5	6	7
Eastern Yamuna Canal	Yamuna	Diversion	7.20	1830	Canal	—
Upper Ganga Canal	Ganga	,,	47.56	1854	,,	—
Doon Canal	Yamuna	,,	2.68	1863	,,	—
Agra Canal	Yamuna	,,	13.28	1873	,,	—
Lower Ganga Canal	Ganga	,,	45.89	1878	,,	—
Betwa Canal	Betwa	Storage	14.02	1886	*Masonry dam/canal	17.37
Rohilkhand Canal	Behgul & Kitcha	Diversion	2.81	1894	Canal	—
Ken Canal	Ken	Storage	30.31	1902	Masonry dam	13.07
Dhasan Canal	Dhasan	,,	5.06	1911	,,	13.70
Ghaggar and Garai Canal	Ghaggar	,,	16.70	1918	,,	22.82
Sarda Canal	Sarda	Diversion	151.7	1927	Canal	—
Ramganga Pumped Canal	Ramganga	,, (lift)	3.06	1935	,,	—
Ghagra Pumped Canal	Ghagra	,, (lift)	5.17	1937	,,	—
Rampur Canal	Small river in Rampur district	Diversion	0.18	N.A.	,,	—
Lilitpur Dam	Shahzad	Storage	4.32	1953	Earthen dam	18.29
Saprar Dam	Saprar	,,	9.50	1956	,,	17.00
Ahraura Dam	Garai	,,	5.90	1956	,,	23.00
Rangwan Dam	Banne-Nadi	,,	12.84	1956	,,	27.43
Shahganj Distributary	Ghaggar	Diversion	2.29	1956	Canal	—
Arjun Dam	Arjun Nadi Badauri Nadi	Storage	11.70	1956	Earthen dam	24.37
Nagwa Dam	Karamnasa	,,	8.34	1957	,,	17.00
Chandraprabha Dam	Chandra-prabha	,,	8.77	1957	Masonry dam	20.10

20.1

4,000 Hectares and Above

work			Canal			
Length (metres)	Capacity (m.cu.m.) Gross	Capacity (m.cu.m.) Live	Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
8	9	10	11	12	13	14
—	—	—	85.00	476,609	209,126	
—	—	—	297.50	1,585,468	716,129	
—	—	—	10.80	18,360	10,920	
—	—	—	92.10	496,560	159,202	
—	—	—	156.50	1,997,288	591,973	
1,168.44	—	83.60	65.60	471,268	119,983	*Paricha dam
—	—	—	18.70	83.006	21,020	
801.28	—	59.65	56.60	312,580	74,354	
542.24	—	36.20	20.97	133,256	23,994	
695.90	—	149.12	N.A.	175,320	38,833	
—	—	—	311.70	2,948,636	605,121	
—	—	—	5.60	38,567	19,224	
—	—	—	8.50	52,164	17,465	
—	—	—	N.A.	126,464	17,426	
3,668	—	93.80	4.55	48,279	7,488	
3,883	—	65.70	N.A.	55,096	16,800	
1,402	—	58.30	N.A.	17,580	8,772	
427	—	156.00	57.40	89,600	37,200	
—	—	—	N.A.	19,000	7,980	
4,543	—	57.79	5.88	48,280	10,640	
1,993	—	397.00	N.A.	96,751	26,920	
1,610	—	70.20	19.40	22,000	14,000	

Appendix

Name of Project	Source of water	Storage/ Diversion	Capital cost (Rs. million)	Year of comple-tion	Storage	
					Type	Max. height (metres)
1	2	3	4	5	6	7
Increasing Capacity of Upper Ganga Canal	Ganga	Diversion	1.61	1957	Canal	—
Naugarh Dam	Karamnasa	Storage	13.63	1957	Composite dam	14.30
Remodelling of Eastern Yamuna Canal	Yamuna	Diversion	6.99	1957	Canal	—
Pratapgarh Branch	Sarda	,,	6.99	1958	,,	—
Sarda Sagar Stage I	Sarda	Storage	47.26	1959	Earthen Bund	12.20
Banganga Canal	Banganga	Diversion	4.51	1961	Canal	—
Narayani Gandak Pokhra Canal	Gandak	,,	9.57	1961	,,	—
Transkalyani	Sarda	,,	5.72	1961	,,	—
Belan and Tons Canals	Belan	Storage	27.92	1961	N.A.	23.75
Afzalgarh Canal	Ramganga	Diversion	1.75	1962	Canal	—
Balmiki (Ohen) Sarovar	Ohen	Storage	6.41	1962	Earthen Dam	24.00
Jirgo Reservoir	Jirgo	,,	12.52	1962	,,	N.A.
Upper Khajuri Reservoir	Khajuri	,,	8.27	1962	,,	9.80
Sarda Sagar Stage II	Chuka tributary of Sarda	,,	73.23	1962	,,	16.20
Tanda Pumped Canal	Ghaghara	Diversion (Lift)	8.52	1963	Canal	—
Remodelling Agra Canal	Yamuna	Diversion	8.02	1963	,,	—
Nanak Sagar	Deoha	Storage	42.04	1964	Earthen dam	16.20
Kwano Pumped Canal	Kwano	Diversion	3.75	1965	Canal	—
Construction of 40 miles channels on Dhanapur Distributary	N.A.	,,	0.63	1965	,,	—
Dohrighat Pumped Canal	Ghaghara	Diversion (lift)	17.51	1966	Canal	—

20.1—*contd.*

work			Canal			
Length (metres)	Capacity (m.cu.m.) Gross	Live	Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
8	9	10	11	12	13	14
—	—	—	N.A.	N.A.	35,600	
7,244	—	87.80	26.50	72,000	34,400	
—	—	—	N.A.	N.A.	8,800	
—	—	—	N.A.	N.A.	18,904	
19,300	—	N.A.	220.80	N.A.	66,960	
—	—	—	7.50	26,080	8,800	
—	—	—	15.60	54,220	23,588	
—	—	—	N.A.	N.A.	18,840	
4,257	—	193.50	13.30	97,200	40,600	
—	—	—	1.68	10,000	4,000	
6,800	—	39.20	3.80	23,020	6,200	
6,700	—	141.50	N.A.	51,200	25,600	
2,320	—	N.A.	18.30	20,740	7,200	
23,496.40	—	3,719	N.A.	448,120	74,060	
—	—	—	10.20	57,800	27,160	
—	—	—	N.A.	N.A.	8,160	
20,116·80	—	4,350	N.A.	N.A.	52,800	
—	—	—	3.40	19,980	8,492	
—	—	—	N.A.	9,688	5,632	
—	—	—	13.50	91,200	47,520	

Appendix

Name of Project	Source of water	Storage/ Diversion	Capital cost (Rs. million)	Year of completion	Storage	
					Type	Max. height (metres)
1	2	3	4	5	6	7
Meja Reservoir	Belan	Storage	33.40	1966	Earthen dam	34.10
Matatila Dam	Betwa	,,	124.60	1966	Masonry dam	36.60
Tumaria Reservoir	Tumaria, Phika, Dhela	,,	21.63	1966	Earthen dam	21.30
Project for 78 miles on Ken Canal	Ken	Diversion	1.03	1966	Canal	—
Pilli Reservoir	Pilli & Dharan Banehi	Storage	24.00	1968	Earthen dam	N.A.
Tumaria Extension	Phika	Diversion	27.00	1968	Canal	—
Baur Reservoir	Baur	Storage	34.00	1968	Earthen dam	N.A.
Jahangirganj Branch	Ghaghara	Diversion	3.36	1968	Canal	N.A.
Musakhand Dam	Karmnasa	Storage	31.50	1969	Earthen dam	N.A.
Barwa Dam	Barwa	,,	6.80		,,	N.A.
East Baigal Reservoir	East Baigal	,,	8.00 (Irrigation share)			N.A.

Source: (1) Irrigation Statistics of India 1960-61, CW&PC, March, 1968.
(2) Note Volume of Irrigation Chapter—Uttar Pradesh, CW&PC, March 1970.
(3) Replies to the Irrigation Commission Questionnaire, Uttar Pradesh Government, Jan., 1970.

20.1—*contd.*

work			Canal			
Length (metres)	Capacity (m.cu.m.)		Full supply discharge (cumecs)	C.C.A. (hectares)	Gross area to be irrigated (hectares)	Remarks
	Gross	Live				
8	9	10	11	12	13	14
2,414	—	5,209	N.A.	54,333	20,956	
6,150.90	—	780	N.A.	273,570	163,832	
13,581	—	84.80	N.A.	32,000	16,000	
—	—	—	N.A.	—	4,332	
N.A.	N.A.	N.A.	N.A.	20,640	11,352	
—	—	—	N.A.	40,000	17,000	
N.A.	N.A.	N.A.	N.A.	34,224	18,676	
N.A.	N.A.	N.A.	N.A.	29,832	13,652	
N.A.	N.A.	N.A.	N.A.	36,756	22,028	
N.A.	N.A.	N.A.	N.A.	23,980	5,392	
N.A.	N.A.	N.A.	N.A.	24,890	7,158	

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